

IN OBSERVANCE OF THE 70TH ANNIVERSARY

— 1956 —

*A Resource Guide to the Grand Canyon Midair Collision
of Trans World Airlines Flight 2 and
United Air Lines Flight 718*

June 30, 1956

third edition

compiled by EARLE E. SPAMER



A Raven's Perch Digital Production



RAVEN'S PERCH MEDIA

Bibliographical and Historical Resources on the
Grand Canyon and Lower Colorado River Regions of the
United States and Mexico

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Flight 718, June 30, 1956

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DIGITAL USERS: The entire text of this PDF document is searchable. Embedded hyperlinks are live. A wide screen is essential for convenient two-page viewing. An opposing-page display is, however, not mandatory for the use of this volume.

NON-INTERACTIVE USERS: The CONTENTS page (p. 7) lists the physical page numbers for the entire volume.

Compiler's Preface

I was nearly four years old when the Grand Canyon air tragedy took place on June 30, 1956, a continent's breadth away from my folks' Walnut Street apartment in Philadelphia. Living with us was my paternal grandfather. He was born in 1869, a generation before the advent of airplanes, yet on this day he still had never flown in one; comparatively few had, in those days. As for the events laid out here, I have no family or other familiar connections beyond that of my more than 50 years' passion for Grand Canyon's history as a bibliographer and chronicler, and my dealings with others who have had the great pleasure of being Canyon travelers, enthusiasts, historians, and government and concessionaire employees. It was not until I began my bibliographical work that I became aware of the events that continue to unfold from that shocking day, which was then just 18 years earlier. My only direct exposure to the crashes is having seen in 1991 a few pieces of wreckage from the United Air Lines plane, lying near the Colorado River across from the mouth of the Little Colorado River. Despite such scant specific connection to the disaster, through things cited in this guide I have shared (though weakly) the emotional despair of the families and friends of the victims, the unfathomably strenuous dangers and reactions of those who recovered remains and artifacts, and the assertiveness of administrators that moved to create the beginnings of modern air traffic control. As is all too often uttered in such circumstances, none of this should have been. Yet, we today are the receivers of beneficial things that managed to come from understanding what happened, from the productive efforts of the legions who made that good come about, and from the efforts of those who have made it possible for we as a nation to remember. The resource guide you are reading is a contribution to this history, as seen and experienced through the eyes, ears, voices, pens, lenses – and tears – of numerous people over the past 70 years. There is far more that could be here – particularly the vast national and international coverage of the accident in the papers, in numerous languages, but it will have to suffice to simply recognize the existence of that archipelago of newsprint. Much in it would be repetitive anyway, yet a diligent search could uncover local, cultural, and personal perspectives since long forgotten. In the meantime, a hike through the resources that *are* collated here should be enough to astonish newcomers to this history. This also is a convenient summary of incidental news, reflections, and historically focused stories after the fact, for the consideration of those who already are familiar with the story. Perhaps a standout citation or two will be enough to inspire a reinvigorated look into some part of this overwhelming event and the repercussions it had around the world.

— E.E.S.

June 25, 2023 [rev. June 2026]

In Memory

Trans World Airlines Flight 2

Harry Harvey Allen
Tracine Elizabeth Armbruster
Thomas Edward Ashton, Jr.
Robert Vernon Beatty
Martha Ann Beck
Stephen Robert Bishop
Connie June Braughton
Esther Ellen McDaniel Braughton
Linda Kay Braughton
Forest Dean Breyfogle
Lois F. Klein Brock
Lillian Estelle Eden Carple
Lawrence Zay Chatten
Sally Ann Cressman
Chester Arnold Crewse
Helen Colleen Crewse
Beth Ellis Davis
Selma Louise Holme Davis
Robert Earl DeLonge
Almeda Inez Babb Evans
Donald Lloyd Flentie
Jack Silvetus Gandy
Virginia Elizabeth Keister Goppert
Janice Tracy Haas
Mildred Rogene Crick Hatcher
William Wallace Hatcher
Janice Mae Heiser
Harry Robinson Holman
James Joseph Jang
Wayne Gardner Jeffrey
Sidney Roland Joslin
Catherine Marie Friedrich Kennaley
Joseph James Kite
Linda JoAnn Kite
Peachie Marie Epley Kite

Sharon Marie Kite
Marie Jane Wilson Klemp
Lois Marie Funderburg Laxton
Michael Anthony Laxton
Mary Ellen Lytle
Claire Marie Schroeder Maag
Howard John Maag
John Otto Maag
Donald Keith MacBain
William Hartzell Markey, Jr.
Rosalie Maude McClenny
Alice Emma Meyer
Andrew Jackson Nasalroad
Robert Bernard Nelson
Marietta Louise Thompson Noel
Richard Curtis Noel
John Walker Payne, Jr.
Monica Jean Payne
Richard Darling Payne
Richard Michael Payne
Robert Farley Perisho
Dennis Joseph Phelan
Neal Alan Power
Edward Merrill Reaves
James Henry Ritner
David Karn Robinson
Geoffry Brian Robinson
Jeanette L. Karn Robinson
Robert Ernest Sanders
Esther Fair Sharp
Robert Frank Sontag
Gloria Kathleen Gipson Townsend
Bessie Nathanielene Whitman
Carolyn Ruth Wiley
Elizabeth May French Young

In Memory

United Air Lines Flight 718

Christopher Edward Balsat, Jr.	Ted Michael Kubinieć
John Aloysius Barry, Jr.	Ray Oliver Lasby
Phyllis C. Goldstein Berman	Sally Lou Laughlin
Rosemary M. Ferry Bishop	Joseph Martin Levis, Jr.
Stephen John Bishop	Theodore Henry Lyman
Gertrude Agnes Coyne Book	Carl Gotfred Matland
Frank Chambers Caple	John Joseph Muldoon
Milton Barry Carlton	Gerald Murchison
Carol Jean Church	Dwight Bradley Nims
Frank Henry Clark	Floyd Arthur Nixon
Leon David Cook, Jr.	Elsie A. Wettlin Osterbrock
Elizabeth Rogers Crider	Hugo Pekruhn
Jeffrey Louis Crider	John George Reba, Jr.
Elizabeth Frances Emery Doering	Alexander Eugene Rosenblatt
Thomas William Doyle, Jr.	Russell Alger Shields, Jr.
Girardo Xavier Fiore	Robert Forbes Shirley
Estella Blum Fuchs	Margaret Ann Shoudt
Walter Moritz Fuchs	Carl Jeramiah Snyder
Noel Henry Gottesman	Fred Robert Staecker
Jack Brothers Groshans	Thomas John Sulpizio
James K. Hadfield	James William Tobias, Jr.
Lillian Ruth Hahn	Albert Vogt
Robert William Harms	Stanley Jerome Weiss
Eugene Barton Hoffman	Peter Austin Whyte II
Russell Charles Huber	Albert Edward Widdifield
Francis Robert Jolie II	Roberta Elaine Wilde
Donald Fredrick Kehl	Donald Lee Winings
Nancy Lou Kemnitz	Wesslau Gilbert Wright
Darenka Dee Kovack	John Edward Yaeger

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National Historic Landmark Nomination (redacted version)	



The very TWA L-1049 Constellation that was lost in the accident—the *Star of the Seine*. Note the single window behind the TWA logo, just forward of the tail. This was the lounge area.



A United Air Lines DC-7 exactly like their plane that was lost in the accident, except for the registration number and the moniker. The plane in the accident was called the *City of Vancouver*.

Photos and legends from Patrons of the 1956 Grand Canyon Midair Collision website, credited to Lostflights archive

BACKGROUND

“An Overview of the Accident”

*by Mike Nelson, author of *We Are Going In*, September 2018*

from the Patrons of the 1956 Grand Canyon Midair Collision website

<https://www.1956gcmidaircollision.com/an-overview-of-the-accident>

Reproduced with the permission of the author

The Grand Canyon midair collision occurred on Saturday, June 30, 1956, at a spot in the sky one or two miles west or southwest from the confluence of the Colorado and Little Colorado rivers, at the eastern end of the canyon. Two four-engine, propeller-driven airliners, some of the biggest in the U.S.A., ran into each other at an altitude of 21,000', at 11:30 a.m., Mountain Standard Time. They had taken off an hour and a half earlier at Los Angeles International Airport, one headed for Kansas City with 70 persons on board, and the other headed for Chicago with 58 persons on board.

As a result of the damage caused in the collision, both planes crashed in the canyon, on the west bank of the Colorado River, taking the lives of all 128 persons aboard. This was by far the greatest loss of life in an airline accident that had ever occurred, anywhere in the world, up to that time. It was also the first and only midair collision between two airliners carrying passengers that had ever happened in the U.S.A., and it involved two reputable airlines, TWA and United Air Lines, no less.

The country was stunned — this was an unthinkable disaster, confidently held to be basically impossible by almost everyone who had thought of the possibility. It seemed preposterous that two huge airliners, readily visible, could even come perilously close together in the wide open sky, without their crews spotting the other plane and taking evasive measures.

The accident happened well removed from both flights' proposed courses, about 12 miles north of TWA's and 20 miles north of United Air Lines'. Neither proposed course passed over the canyon, but in those days sightseeing jaunts were common for flights that skirted nearby.

It is fairly certain that United Air Lines was over the canyon for just this purpose, while TWA may have been there for the same reason, or to circumnavigate the huge cloud that was blocking their proposed course.

Either way, they came around opposite sides of the massive cloud and ran into each other; and just to be completely clear, this was in the open air — neither of them flew through the cloud.

One twentieth of a second was all that separated all of those people from life. Had the TWA plane taken off 1/20th of a second sooner, or the United Air Lines plane 1/20th of a second later than it did, the planes would have just barely missed each other, and what happened that day would have been only a significant but obscure incident lost to the annals of history.

These wishful thoughts aside, in the reality that ensued the United plane lost the outer third of its left wing, and the TWA plane lost its entire tail section. The TWA plane went completely out of control and tumbled end-over-end to the earth; the United plane entered a left-turning, downward spiral and was still marginally flyable, though terribly hampered.

From the evidence later found in the wreckage, it appeared that the pilot of the United plane managed to gain a measure of improvised control, but tragically he lost it just seconds before the crash, when his own tail section came apart. Had this not happened, the United plane would have overflowed the rocky promontory that it hit, and its pilot may have been able to perform a belly landing on the Colorado River.

An hour and a half later, with both flights having failed to report their positions for all that time, a Missing Aircraft Alert was issued and the United States Air Force launched a full-scale search and rescue mission. Despite their great effort, they were unable to find the wreckage that day, even though both crash sites had become infernos giving rise to great, tall columns of black smoke; apparently the overcast in the crash area hid the sites from the view of the aircraft above.

Out of all proportion to the massive search effort, the wreckage was actually discovered just before dusk that evening by a private pilot who had seen the smoke earlier in the day, around lunchtime, when he had flown tourists near the area for sightseeing. He heard a report on the radio that evening that two airliners were missing and he immediately realized what the smoke he saw midday must have been; he hurriedly flew back to the area and identified the TWA wreckage from the markings on its tail section. Nightfall was fast approaching and for his own safety he had to leave the depths of the canyon to fly home, without examining the second still-burning area a mile north, though he was sure it must be the United plane.

He called TWA's headquarters in Kansas City and reported his find, but by then it was too dark out for the air force to fly over the area and verify his information. That had to wait until the following morning at dawn, at which time the air force positively and officially identified both wrecks.

Across the nation many hundreds of families, those of the victims and their friends, had lived through the worst night of their lives, with their loved ones missing, and now, on Sunday, they received the awful word that both planes had crashed and that no survivors were expected.

One of those families was my own — my uncle, Jack Groshans, was a passenger on the United plane.

For the families and friends of the victims, the coming days were a seemingly eternal nightmare of praying for a miracle and direly fearing the worst. The families waited in excruciating alertness for the phone to ring with the dreaded call informing them that their loved one had been positively identified, and the friends waited in a parallel, persistent agony, for the correspondingly dreadful call from the families.

Only 39 of the 128 victims were positively identified — 10 from the TWA plane, and 29 from the United plane. The rest of the remains were buried in two common graves, TWA's in Flagstaff, Arizona, and United's in Grand Canyon Village, Arizona. Six of the identified TWA victims were buried along with the unidentified remains at TWA's mass gravesite, at the request of the families; all of United's 29 identified victims were sent home for burial.

TWA held a funeral service on Monday, July 9, 1956, with approximately 350 family members in attendance, and roughly 1,500 citizens of Flagstaff in solemn, reverent observance in the background. Clergymen from four faiths gave sermons. It was an overwhelming event, so much so that even the men of the military honor guard cried. 67 caskets were on display (one of which was sent home after the service) and seemed to extend forever in the three columns, stretched out in front of the congregation. At the end of the service, as the mourners passed in front of their loved ones for the last time, eight of them were overcome and collapsed; they were taken to a Red Cross tent, which had been set up in anticipation of such unendurable emotional crises.

United held a memorial service on Thursday, August 2, 1956, in front of a very large, standing headstone, and an already-closed gravesite, with the acceptance and agreement of the families. This ostensibly odd arrangement was due in part to the fact that the huge limestone marker was not yet in place by the time the unidentified remains needed to be interred. It was also due to the grievously distressing fact that there were only four caskets for the unidentified remains, even though 29 victims from the United plane were not identified. This demonstrated unequivocally that most of the unidentified victims were just plain

missing, undiscovered somewhere up on the butte where the plane crashed, a fact that would have been cruelly too much to bear for most of the mourners. So the four coffins were buried before the service.

The trauma of unexpectedly losing a loved one cannot be conveyed, but only suggested. In the face of such devastating misfortune we are confronted with our powerlessness, our ignorance and our helplessness as much as with our bereavement, to such a degree that the ordeal might as well be a tortured nightmare from a reality entirely removed from the one we have known. Because it is so alien and incomprehensible, it can seem like an illusion or a netherworld, a half-world that just doesn't "add up." On the other hand, because it is so starkly terrible, it can seem like it is in nature more real than anything a person has known before. And both views are right. Either one by itself, and especially the two combined, is utterly bewildering and leaves a person defenseless against his sorrow and grief. These take on proportions beyond measure and are absolutely rending.

This was the plight of a multitude of family and dear friends of those who were lost, and it continued in phases through the succeeding years, often taking them by surprise. There's no such thing as getting over a tragedy such as this — only creating a new life and lapsing into periods of forgetfulness or times when an encouraging viewpoint takes precedence over the unanswerable pain of the loss.

Twenty years after the accident, in 1976, a massive effort was made to clean up the wreckage and most of it was removed. Nowadays, numerous small parts and fragments remain, but there is little or no sign from the river or the east rim that anything ever happened there.

MARKERS



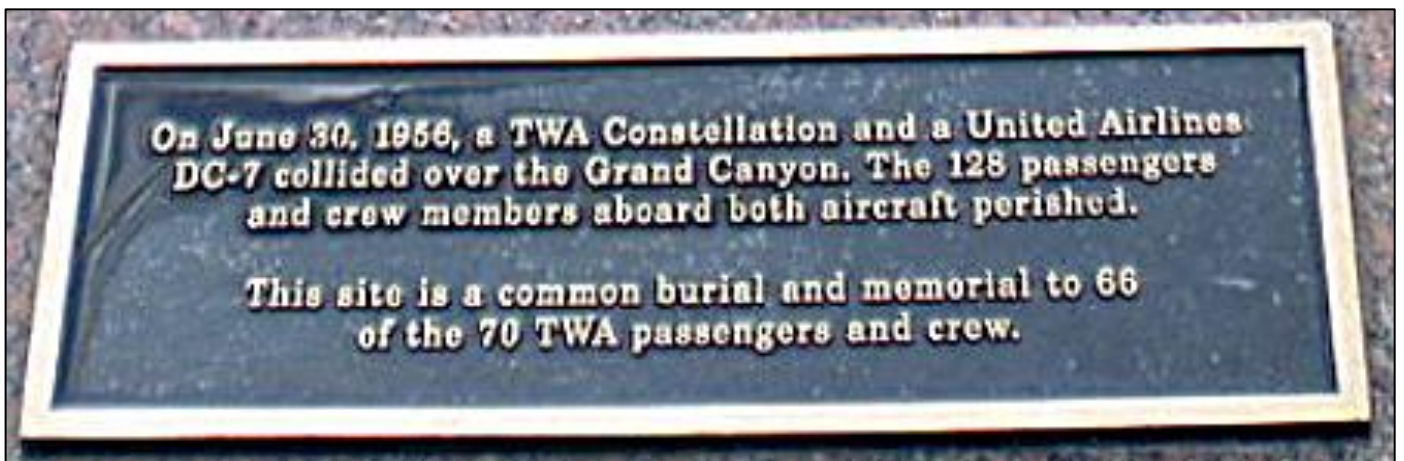
Patrons of the 1956 Grand Canyon Midair Collision

United Air Lines Flight 718 gravesite
Grand Canyon Pioneer Cemetery
Grand Canyon, Arizona
Coordinates: 36.05450, -112.12510



Patrons of the 1956 Grand Canyon Midair Collision

Trans World Airlines Flight 2 gravesite
Citizens Cemetery
1300 S. San Francisco St
Flagstaff, Arizona
Coordinates: 35.18656, -111.65170





Patrons of the 1956 Grand Canyon Midair Collision

Commemorative marker at Desert View, Grand Canyon National Park

Overlooking the scene of the accident from Desert View, Grand Canyon National Park



The crash sites are in the distance at far left, to the west of the Colorado River, on the cliffs and in a side canyon at the cliff base. The sites are *not* open to visitation.

RESOURCES

Online Resources

[All links were valid as of June 24, 2023]

PATRONS OF THE 1956 GRAND CANYON MIDAIR COLLISION

<https://www.1956gcmidaircollision.com>

The website, which continues to be expanded, includes a variety of informational images of newspaper front pages, which reported the accident in 1956; personal stories; photo galleries of individuals and commemorative events; historical background and photos of the National Historic Landmark dedication at Desert View, Grand Canyon National Park; an “events” page; and an online blog.

From the “About Us” page:

“Patrons of the 1956 Grand Canyon Midair Collision serves to facilitate support among the families who lost a loved one in the tragedy; to preserve and teach the history of the accident itself and the profound and lasting effects it had on everyone it touched; and to help involve everyone who cares to be involved, whether they lost a loved one or not, creating a fellowship amongst us all.

“In the broader sense a family is a group of persons who hold each other's values, purposes, and welfare dear. In this perspective, ‘family’ does not strictly have to be descendants, kin, or relatives by marriage, but rather the larger group of persons who matter to each other. Most of us have friends who we say are ‘just like family,’ and many of us drop ‘just like’ and call these persons family. In this spirit anyone who reveres the victims and recognizes what happened to them is welcome to join our group. In fact, two of our founding members are not related to any of the victims, yet as far as we are concerned, they are as much insiders as anyone else.”

FEDERAL AVIATION ADMINISTRATION

Lockheed L-1049 Super Constellation and Douglas DC-7
Trans World Airlines Flight 2, N6902C
United Airlines Flight 718, N6324C
Grand Canyon, Arizona
June 30, 1956

Informational webpage with dropdowns

https://www.faa.gov/lessons_learned/transport_airplane/accidents/N6902C

**NATIONAL PARK SERVICE, GRAND CANYON NATIONAL PARK,
GRAND CANYON MUSEUM COLLECTION**

The collection includes TWA-United Air Lines accident files (not online). Information regarding access to the Museum Collection is on the museum webpage:

<https://www.nps.gov/grca/learn/historyculture/muscol.htm>

**NORTHERN ARIZONA UNIVERSITY, CLINE LIBRARY,
COLORADO PLATEAU DIGITAL COLLECTIONS**

Expedition and wreckage from the 1956 Trans World Airlines and United Airlines crash over the Grand Canyon [constructed title], 1956-2006.

Creator: Mike McComb

NAU.PH.2006.29

"This collection consists of 138 digital copies of airline wreckage images from a 1956 airline collision over the Grand Canyon. Images range in date from 1956 to 2006 and include the TWA and United DC-7 crash sites and wreckage, as well as scenic views taken during expeditions in the early 1990s and 2006. The original photographs reside with the donor, not the Cline Library." "Digital surrogates are the property of the repository. Reproduction requires permission."

14 pages online. Page 1: <https://archive.library.nau.edu/digital/collection/cpa/id/59040>

LOST FLIGHTS.COM

Page includes numerous photographs pertaining to the accident, some of the people, and the aircraft involved.

<https://www.lostflights.com/Grand-Canyon-Aviation/63056-Trans-World/>

GRAND CANYON HISTORICAL SOCIETY, ORAL HISTORY PROJECT

<https://www.grandcanyonhistory.org/oral-history/>

Several oral history interviews have been conducted with family members of some of the victims of the midair collision, and one person who was employed at Grand Canyon at the time. Recordings and/or transcripts of the interviews are provided. These entries have been copied directly from the GCHS website (accessed June 14, 2026). Each link will show links on that page for transcripts and .mp3 digital audio files (the audio files can be very large, to about 1GB).

Ray and Christa Cook

Ray and Christa Cook recall Ray's father David Cook who perished in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/ray-and-christa-cook/

Ervin and Raymond Cook

Ervin Cook, brother of David Cook, and Ervin's nephew Raymond Cook, recall David Cook who perished in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/ervin-and-raymond-cook/

Steve and Dave Evans

Steve and Dave Evans recall their mother Almeda Evans who perished in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/steve-and-dave-evans/

John Hasha

On July 1, 2022, one day after the 66th Memorial of the 1956 United–TWA midair collision over Grand Canyon, John was interviewed by Grand Canyon National Park archivist Kim Besom. John is the nephew of the United Airlines Flight Engineer Geraldo Fiore. John kindly allows the GCHS to post this Museum Collection interview here. (The interview is not yet transcribed.)

https://www.grandcanyonhistory.org/oral_history/john-hasha/

Etta, Dana and Deeana Jang

Etta and her children Dana and Deeana Jang, recall Etta's husband James Jang, who perished in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/etta-dana-and-deeana-jang/

Lisa Kaichen

Lisa recalls her father, Noel Gottesman, who perished in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/lisa-kaichen/

Anne Klein

Anne's first cousin Immaculata Sceia ("Mac" for short) married Tom Sulpizio. When Tom perished in the 1956 TWA–United air disaster, Anne was 14 years old and a close friend of Mac's. Anne recounts her recollections of that terrible time.

https://www.grandcanyonhistory.org/oral_history/anne-klein/

Janice McElroy

Janice recounts the loss of her mother and father, Mildred R. Crick Hatcher and William W. Hatcher, who perished in the 1956 TWA–United air disaster.

At Janice's request and direction, this transcript has been edited and there is no recording. We greatly appreciate Janice taking the time to do this.

https://www.grandcanyonhistory.org/oral_history/janice-mcelroy/

Cathy Natall and Lea Garcia

Cathy and Lea, daughters of Ray Lasby, recall their father who died in the 1956 TWA–United air disaster.

https://www.grandcanyonhistory.org/oral_history/cathy-natall-and-lea-garcia/

Paul and Barbara Schnur

In Part 1, Paul recounts working as a Bellhop at the Bright Angel Lodge on June 30, 1956, during the TWA–United Air Disaster. In Part 2, Paul recounts family stories that brought him to the Canyon in 1946 and his recollections of the South Rim and the people there from 1946 to 1956.

https://www.grandcanyonhistory.org/oral_history/paul-and-barbara-schnur/

Tom Sulpizio

Tom Sulpizio recounts the loss of his father, Thomas J. Sulpizio, an Electronics Engineer working for Rheem and traveling on United Flight 718 with Ray Lasby, another Electronics Engineer. Tom recounts how the loss of his father impacted him, his mother, and other family members. No .mp3 file is available.

https://www.grandcanyonhistory.org/oral_history/tom-sulpizio/

GRAND CANYON HISTORICAL SOCIETY VIRTUAL OUTINGS

May 2026, Mike McComb Presented

"Grand Canyon 1956 Midair Collision: What Aviation Archaeology Reveals

<https://www.youtube.com/watch?v=1fLtUZats2A&list=PLU09f0bN49vn8wwzGw47GzGVypkBHmJac&index=2&pp=iAQB0gcJCSgLAYcqIYzv>

October 15, 2024, Mike Nelson Presented

"We Are Going In" The Story of the 1956 Grand Canyon Midair Collision - Part 1

vimeo.com/1020034563/a30be2a8f6

December 10, 2024, Mike Nelson Presented

"We Are Going In" The Story of the 1956 Grand Canyon Midair Collision - Part 2

vimeo.com/1038063883

September 17, 2024, Tom Sulpizio Presented

The 15 Technologists and the 3 Aviator Crew Members of United Flight 718 Some of the Nation's Leading Technologists and Aviators Perished on Chuar Butte on June 30, 1956

vimeo.com/1010452453

Also accessible are the 50-year anniversary symposium video presentations at Grand Canyon 1956 Air Disaster Symposium

<https://vimeo.com/showcase/5627770>

Articles, Books, Reports, and Films

Bibliographical citations are extracted from

THE GRAND CANON

A WORLDWIDE BIBLIOGRAPHY OF THE
GRAND CANYON AND LOWER COLORADO RIVER REGIONS
IN THE UNITED STATES AND MEXICO

VOLUME 1, PART B : BIBLIOGRAPHY (5TH EDITION 2025)
AND CUMULATIVE SUPPLEMENT (TO JUNE 2026)

CATALOGERS NOTE

canon : *a standard or
essential list of works*

RAVEN'S PERCH MEDIA <https://ravensperch.org>

Anonymous (not signed)

- 1956 Entire company shaken by tragic loss. *Skyliner* (Trans World Airlines [TWA], Weekly Employee Publication), (July 5): 1, 3. [Air crash.]
- 1956 Hazardous job continues at site of crash. *Skyliner* (Trans World Airlines [TWA], Weekly Employee Publication), (July 5): 1, 3.
- 1956 Eine schreckliche Flugzeugkatastrophe [*transl.* 'A terrible plane disaster']. *In*: Politisches und anderes [section]. *Schweizer Frauenblatt* (Bern), 35(27) (July 6): [2]. [*In German.*]
- 1956 De Suiza a USA en obra de salvameno [*transl.* 'From Switzerland to the USA in a rescue project']. *La Nacion* (Santiago, Chile), 40(14,094) (July 7): 1.
[*In Spanish.* United Press radiophoto, with longer legend, showing eight Swiss mountain climbers led by Max Stamfli, arriving in New York en route to Grand Canyon, to aid in recovery efforts following the Grand Canyon air crash.]
- 1956 Stations get quick details on Grand Canyon disaster. *Broadcasting, Telecasting*, (July 9): 68. [Air crash.]
- 1956 Painted Desert: 11:31. *Time*, (July 9):. [Air crash.]
- 1956 Son haber. *In*: Ulaştırma [SECTION], Kazalar [SUBSECTION]. *Akıs* (Haftalık Aktüalite Mecmuası) (Ankara), 3(7)(114) (July 14): 27.
[*In Turkish.* Citation translated: Latest news. *In*: Transportation [SECTION]. *Echo* (Weekly Current Events Magazine) (Ankara, Turkey).]
- 1956 A perilous searching operation. *Life*, 41(3) (July 16): 19-25. [Air crash.]
- 1956 Action is needed on air safety. *Life*, 40(3) (July 16): 32. [Editorial.]

- 1956 A tranquil grave for crash dead. *Life*, 41(5) (July 30): 34. [Photo of 67 coffins in common grave for TWA airliner victims of Grand Canyon air crash, Flagstaff Cemetery.]
- 1956 Kansas City rector flies to Flagstaff to take charge of committal for victims of Grand Canyon plane crash. *The Living Church* (Milwaukee, Wisconsin), 133(6) (August 5): 16. [Rev. Laurence Spencer, rector of St. Michael and All Angels Episcopal Church, Kansas City. Service with family members of victims in the TWA airliner crash in Grand Canyon, interred at Flagstaff, Arizona. Article also includes commentary on services held by Rev. Dallis L. Harris, rector of the Church of the Epiphany (Flagstaff, Arizona), at St. Andrew's chapel in Supai, Arizona, where he was when he heard of the United Airline-TWA crash at Grand Canyon. The article includes a photo credited to Dal Harris showing Rev. Spencer presiding over the mass grave in Flagstaff.]
- 1956 [Recovery work at Grand Canyon air crash.] *In*: News At Random [SECTION]. *The Swiss Observer* (Swiss Colony in Great Britain), 41(1279) (August 17): 8457. ["A Swiss team of five, specially trianed in mountain rescue work, flew to the spot where the air disaster occurred in the Grand Canyon to help in rescue work. [¶]Amongst the victims of the disaster is a Swiss, Dr. Albert Vogt-Schoch, Director of the Zurich Insurance Company, in Chicago." (ENTIRE NOTE)]
- 1956 Air tragedy memorial. *In*: Here and There on the Desert [SECTION]. *Desert Magazine*, 19(9) (September): 28. ["A drive is underway in Coconino County, spearheaded by Flagstaff's radio station KCLS, to erect a large copper table memorial to the 128 persons who lost their lives in the air tragedy over the Colorado in late June. Plans call for the tablet to be inscribed with a brief account of the tragedy and the names of the victims.—*Northern Yavapai Record*." (ENTIRE ITEM) Grand Canyon air crash.]
- 1956 Another collision; an editorial. *The AOPA Pilot* (Aircraft Owners and Pilots Association, Washington, D.C.), (September): 50-a to 50-b. [*The AOPA Pilot* is an insert in *Flying*, 59(3) (September).] [Regarding the 1956 Grand Canyon air crash.]
- 1956 Congress gets AOPA's views on collision. *The AOPA Pilot* (Aircraft Owners and Pilots Association, Washington, D.C.), (September): 50-b to 50-c. [*The AOPA Pilot* is an insert in *Flying*, 59(3) (September).]
- 1956 Sinestres et catastrophes dans le monde [*transl.* 'Disasters and catastrophes in the world']. *La Croix-Rouge Suisse* (Berne), 65(6) (September 1): 3-7.
[*In French.* See "Catastrophe aerienne aux Etats-Unis; les deux avions ecrases dans le Grand Canyon" ['Air disaster in the United States; two planes crash into the Grand Canyon'] (pp. 3, 5-6).
- 1956 Wesslau G. Wright, '40. *Princeton Alumni Weekly*, 57(8) (November 9): 35. [Wright was aboard the United Airlines DC-7 that crashed in Grand Canyon.]
- 1956 William H. Markey, Jr. *In*: Deaths [SECTION]. *American Hospital Association, Journal*, 30: 92. [Markey was aboard the TWA Constellation that crashed in Grand Canyon.]

This boxed section of citations is provided so as to keep together all pertinent reports from the *American Aviation Daily*, published in Washington, D.C., by American Aviation Publications, Inc. Regular chronologically arranged citations continue afterward.

- 1956 TWA-UAL accident may set off ATC inquiry. *American Aviation Daily*, 105(2) (July 3): 17-18. [*NOTE*: This is the first mention of the Grand Canyon accident in *American Aviation Daily*.]
- 1956 ATCA takes exception to Smathers statement. *American Aviation Daily*, 105(3) (July 5): 27. [Begins, "The newly formed Air Traffic Contol Association, in its first public stand on a traffic control

- controversy, yesterday took issue with Sen. George A. Smathers (D-Fla.) for prejudging the cause of the week end collision of United and TWA aircraft over Grand Canyon.”]
- 1956 House group to visit canyon accident site. *American Aviation Daily*, 105(4) (July 6): 44. [Begins, “Investigation by the House Interstate and Foreign Commerce Aviation Subcommittee into the June 30 collision of United and TWA transports over Grand Canyon got under way yesterday with the announcement by chairman Oren Harris (D-Ark.) that the group would visit the scene of the crash.”]
- 1956 Magnuson says committee will recommend radar for air transports. *American Aviation Daily*, 105(5) (July 9): 49. [Sen. Warren Magnuson (D-Wash.), chairman of the Senate Commerce Committee, “has predicted his group will recommend that radar be installed in all commercial passenger aircraft.” He also “announced that his committee will look into the situation surrounding the mid-air collision of TWA and United airlines last week over the Grand Canyon. ‘If those two planes had had radar,’ he declared, ‘the crash never would have occurred.’”]
- 1956 Accident has no adverse effect on air traffic. *American Aviation Daily*, 105(5) (July 9): 50. [Includes notes, “TWA’s traffic is ‘holding up to predictions’” and “United has noticed no reduction business.”]
- 1956 Durfee, CAB aides visit Ariz. accident site. *American Aviation Daily*, 105(5) (July 9): 50. [“CAB Chairman James R. Durfee and a group of top staff officials were scheduled to leave Friday with the Congressional delegation which earlier had announced plans to visit the scene of the United-TWA Grand Canyon air accident. Included in the CAB group with Durfee were General Counsel Franklin M. Stone and Ross I. Newmann, chief, International & Rules Division.”]
- 1956 Investigative bungling seen in canyon air disaster. *American Aviation Daily*, 105(6) (July 10): 64-65. [Begins, “The fact that the Grand Canyon air disaster was the worst in commercial aviation history is fast being submerged by the worst investigative bungling in aviation history, both on the part of CAB and the House Aviation Subcommittee. [¶]Top CAB investigators, always close-mouthed in the past during an investigation, have already fixed the blame for the accident although public hearings are still a month away and a full investigative report is many months from completion! [¶]House investigators, relegating to the background the Government agency with a 98% record of solving all air accidents, held ‘urgent’ on-the-spot hearings Saturday in a plush Las Vegas gambling resort—135 miles removed from the scene.” It also “forced government investigators to leave the scene of the accident to participate.”]
- 1956 Durfee “takes charge” of accident inquiry. *American Aviation Daily*, 105(7) (July 11): 73. [Begins, “CAB Chairman James R. Durfee took charge of the Grand Canyon air accident investigation yesterday with an emphatic statement that no one, including CAB and Congressional investigators, knows what caused the accident. Any conclusions as to the cause or responsibility prior to completion of CAB’s investigation, Durfee said, are ‘decidedly premature.’” Concludes, “He scored the ‘impropriety of premature conclusions, particularly because no one saw what happened’ (at Grand Canyon).”]
- 1956 Anti-collision problem to get widest attention—(an analysis). *American Aviation Daily*, 105(10) (July 16): 107-108.
- 1956 UAL-TWA accident hearing starts in Wash. Aug 1. *American Aviation Daily*, 105(10) (July 16): 108.
- 1956 Multi-million dollar ins. claims stem from canyon mishap. *American Aviation Daily*, 105(11) (July 17): 125.
- 1956 ATA committee speeds action on anti-collision device *American Aviation Daily*, 105(14) (July 20): 156. [Notes that the committee of the Air Transport Association had been “named just one day before the TWA-UAL Grand Canyon collision accident”.]

- 1956 Speech by Curtis aide stirs industry protests. *American Aviation Daily*, 105(18) (July 26): 195-196. [Begins, "The air transport industry was incensed yesterday over a speech delivered in Washington by an aide to Edward P. Curtis, aviation facilities planner, which purportedly warned that the number of mid-air collisions will increase in number." Focus was on air traffic control. "Curtis, in a statement issued to temper the effects of his aide's speech, found that one result of the public discussion and press comment on the Grand Canyon accident 'has been to lose some sense of perspective about the overall problem.'"]
- 1956 July slump in domestic air traffic reported. *American Aviation Daily*, 105(19) (July 27): 213. ["Sales officials give the following reasons: 1. Grand Canyon accident. Reaction to this was not immediate. Continuing publicity, stories of near-misses, possibility of more collisions, inadequate traffic control, etc., have been responsible." Adds various economically driven influences.]
- 1956 ALPA group recommends ATC policy actions. *American Aviation Daily*, 105(19) (July 27): 213. [Begins, "Air Line Pilots Association's Air Traffic Control Committee yesterday concluded a three-day meeting in Chicago by releasing seven proposals which it felt were 'immediately implementable and, had they been in effect, would undoubtedly have prevented the Grand Canyon crash.'"]
- 1956 Public hearings in canyon accident open tomorrow. *American Aviation Daily*, 105(21) (July 31): 234.
- 1956 Mechanic claims to have witnessed Grand Canyon collision. *American Aviation Daily*, 105(23) (August 2): 248-249. [At the CAB public hearing on the Grand Canyon accident, "Eugene J. Siefer, a 24-year old Ottawa, Ohio, equipment mechanic employed by Sylvania Electric Products, Inc., told the hearing panel that he and his wife observed the collision while driving west along U. S. route 66 about 12 to 15 miles east of Flagstaff, Ariz." Also, "The witness explained that he failed to report the observation immediately because he intended to return to Ohio promptly and did not want to be delayed on the west coast. First detailed report was given to a local Ohio newspaper on July 10, ten days after the accident, and first statement was sent to CAB on July 24."] [NOTE: As a point of reference, the Siefers were approximately 75 miles from the accident scene.]
- 1956 AA pilot gives weather testimony at Grand Canyon hearing. *American Aviation Daily*, 105(24) (August 3): 262.
- 1956 CAB report reveals how UAL, TWA planes collided. *American Aviation Daily*, 105(25) (August 6): 272. [Includes a separate section, "ATC Aware Planes Were Close".]
- 1956 Grand Canyon accident indicated as "legal". *American Aviation Daily*, 105(26) (August 7): 287. [Begins, "CAB hearing into the cause of June 30 collision of United and TWA aircraft over Grand Canyon came to a close late Saturday afternoon with every indication that the disaster was an entirely "legal" event by today's air traffic control standards." Testimony of D. D. Thomas, CAA director of air traffic control. Notes, "When subsequently questioned as to why the densely-traveled accident-route was not a controlled Federal airway, Thomas attributed [sic] this to lack of funds, personnel and equipment."]
- 1956 Flight Safety Foundation Awards of Merit. *American Aviation Daily*, 105(28) (August 9): 307. [Flight Safety Foundation Awards of Merit were presented yesterday in New York to representatives of the three military units which participated in survey and rescue operations following the June 30 Grand Canyon air collision. They were: Luke AFB, Ariz.; 14th Army Aviation Co. and 93d Transportation Co., both from Fort Huachuca, Ariz." (ENTIRE ITEM)] [Refer also to Taylor (1956).]
- 1956 Trends and Forecasts (Transport) [SECTION]. *American Aviation Daily*, 105(35) (August 20). [See p. 373: "Prospects are extremely doubtful, based on present evidence, that CAB final accident report on Grand Canyon collision will attempt to define exact impact sequence. And, without this information, blame for accident is almost impossible to fix." (ENTIRE ITEM)]

- 1956 84th Congress much concerned with air safety (special report). *American Aviation Daily*, 105(38) (August 23): 408-. [See p. 408: "TWA-United collision—which took place over the Grand Canyon on June 30—brought (1) a House Commerce Subcommittee rushing blindly to the scene for a 'pro forma' exhibition, and (2) an acknowledged 'speed-up' in the Administration's request for more Federal airways money." (ENTIRE NOTE)]
- 1956 CAB to send investigator back to canyon accident site. *American Aviation Daily*, 105(44) (August 31): 465. ["CAB has assigned investigator John Paul to accompany officials of the insurance company representing TWA to Grand Canyon during mid-September for an on-the-spot examination of wreckage from the TWA-United collision. The area has been 'closed' by Park officials since the accident, and the scene may be visited only when a CAB investigator is on hand. (ENTIRE NOTE)]
- 1956 Magazine predicts Curtis to become embroiled in politics. *American Aviation Daily*, 105(44) (August 31): 468. [Begins, "A predication that special Presidential aide Edward Curtis 'will be up to his ears in politics' before he is through is made in an article in the September issue of Harper's Magazine." [see Conine (1956)]. Adds, "The article, provocatively titled 'Russian Roulette on Our Airways?,' maintains that the airlines 'were shocked, but not surprised' over the TWA-United collision over the Grand Canyon. 'They had feared such an accident was long overdue, and were relieved that it had happened over an empty gorge in Arizona instead of over the crowded streets of Manhattan as they half-expected.'"]
- 1957 SDX selects eight for radio-TV awards. *Broadcasting, Telecasting*, (April 22): 44. [Sigma Delta Chi awards include one to Edward (Johnny) Green of KPHO Phoenix for his coverage of the June 30, 1956, airliners crash in Grand Canyon. Photo of Green included.]
- 1957 [Photograph of man's hand holding two rings.] *In*: Datelines [SECTION]. *Broadcasting, Telecasting*, (September 2): 76. ["These are two rings taken from a severed hand found near the site of wreckage of the TWA plane involved in the air disaster over Grand Canyon in June 1956. Bill Close, news editor, KOY Phoenix, holds the rings in front of the UP [United Press] release telling of the station's interview of the man who found them." (ENTIRE ITEM) Photo only.]
- 1957 La Garde Aérienne Suisse de Sauvetage. *Revue Internationale de la Croix-Rouge* (Comité International de la Croix-Rouge, Genève), 39(467) (November): 593-601. [1956 Grand Canyon air crash, see pp. 593, 600.]
[In French. Citation translated: The Swiss Air Rescue Guard. International Review of the Red Cross (International Committee of the Red Cross, Geneva).]
- 1987 Grand Canyon collision. *Flying*, 114 (September): 22+. [Overview of air traffic control stemming from the June 30, 1956, air crash.]
- 2006 [Note about 1956 airliner collision over Grand Canyon.] *In*: Hangar Flying [SECTION]. *The Aileron* (Southern California Aeronautic Association), (August/September): 7.
- 2008 1956 年グランドキャニオンでの空中衝突. *ALPA Japan News* (日本乗員組合連絡会議 / Air Line Pilots' Association of Japan, Tokyo), No. 31-36 (April 22): [1]-[2]. [Regarding the 1956 airline crash in Grand Canyon.]
[In Japanese, with serial title in English, thus. Title in transliteration: 1956-nen gurandokya ni on de no kūchū shōtotsu. Title translated: 1956 aerial collision at the Grand Canyon.]
- 2009 Air disaster recognized for contributions 52 years later. *Babbitt Times Review* (Babbitt Ranches), (July): 12. [1956 air crash in Grand Canyon.]

- 2014 Remembering game-changing Canyon plane crash. *Aviation Human Factors Industry News*, 10(14) (July 13): 9-11. [National Landmark status for 1956 Grand Canyon air crash sites.]
- 2015 Tribute to a tragedy. *Grand Canyon Journal*, 2015: 27. [Dedication of 1956 air crash site as a National Historic Landmark.]
- 2016 GCHS and the NPS sponsor 60th anniversary commemoration of the tragic 1956 air collision over Grand Canyon. *The Ol' Pioneer* (Grand Canyon Historical Society), 27(3) (Summer): 20-22.
- 2019 United-TWA collision over Grand Canyon. *RUPAnews* (Retired United Pilots Association), 22(3) (March): 33. [Regarding the 1956 air collision.]
- 2021 Sixty-fifth anniversary of the 1956 Grand Canyon midair collision. *In: The Bulletin* [NEWSLETTER SECTION]. *The Ol' Pioneer* (Grand Canyon Historical Society), 32(3) (Summer): 18. [NOTE: This issue mistakenly labeled on masthead (p. 2) as the Spring issue; correct on the cover.]
- 2022 Sixty-sixth anniversary of the 1956 Grand Canyon midair collision. *In: The Bulletin* [NEWSLETTER SECTION]. *The Ol' Pioneer* (Grand Canyon Historical Society), 33(3) (Summer): 19. [Summary of commemorative events at Grand Canyon.]
- 2023 1956 Grand Canyon midair collision 67th commemoration; Friday June 30th at South Rim 10:30 a.m. Pioneer Cemetery in Grand Canyon national Park, Citizens' Cemetery in Flagstaff (1300 S. San Francisco St., Flagstaff, AZ. 86001). *In: The Bulletin* [NEWSLETTER SECTION]. *The Ol' Pioneer* (Grand Canyon Historical Society), 34(2) (Spring): 19. [Announcement.]

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- 2004 Collision avoidance; strategies and tactics. *Safety Advisor, Operations and Proficiency*, (4). [See p. 2, 1956 mid-air collision over Grand Canyon noted *in passing*.]

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- 1956 Statement of William K. Andrews, Director, Bureau of Safety Investigation, Civil Aeronautics Board. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 3-24. [Relating to the 1956 Grand Canyon air crash.]

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- 1956 Statement of Milton W. Arnold, Vice President of Operations and Engineering, Air Transport Association. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 316-331. [Relating to the 1956 Grand Canyon air crash.]

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- 1956 Statement of Oscar Bakke, Deputy Director, Bureau of Safety Regulation, Civil Aeronautics Board. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 39-48, 144-198. [Relating to the 1956 Grand Canyon air crash.]

Berger, Todd R.

- 2006 The 1956 airliner disaster at Grand Canyon. *Canyon Views* (Grand Canyon Association), 12(2) (Summer): 1-3.
- 2006 The worst commercial airplane accident the world had ever seen. *The Bulletin* (Grand Canyon Historical Society), 10(6): 1, 3.

Block, Thomas

- 2002 Collisions, Part III. *In*: Touchdown [SECTION]. *Flying*, 129(11) (November): 98-101. [Recounts in part the 1956 mid-air collision of two commercial airliners over Grand Canyon, pp. 98-101.]

Breyfogle, Dan

- 2007 Mid-air collision—1956. *Breyfogle Sentinel Dispatch* (Mason City, Iowa), 3(1) (February): 4-5. [A geneological newsletter. Item is regarding the 1956 aircraft collision over Grand Canyon. Notes that Paul Breyfogle had two cousins who flew at this time, one for TWA and other other for United Airlines (which were the airlines involved in the Grand Canyon crash). There had been initial concern that one of them had been a victim, but this was Forrest Dean Breyfogle, whose relationship to the Breyfogle family was uncertain. The article recounts the events of the crash, and asks readers for further details that may be known about this man.]

Brown, Dick

- 2022 President's letter. Remembering June 30, 1956. *The Ol' Pioneer* (Grand Canyon Historical Society), 33(3) (Summer): 2.

Burns, Trish

- 1996 One-thousand feet on top of the clouds. *Nature Notes* (Grand Canyon National Park), 12(3) (Fall): 6. [1956 air crash.]

Burris, Roy E.

- 1992 Roy Burris' reaction to the TWA crash. *Grand Canyon Pioneers Society, Newsletter*, 3(5): 4. [See also letter in 4(9): 8 (1993).] [TWA-United crash in Grand Canyon, 1956.]

Cadwalader, Mary H.

- 1957 Air mystery is solved. *Life*, 42(17) (April 29): 151-152, 154, 156, 158, 163-164. [1956 air crash.] [See also correspondence from Ed Gillet, Max Karant, and Ted Boehner, 42(20) (May 20): 16.]

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- 2010 *Seeing disaster in Grand Canyon : rethinking the 1956 Grand Canyon mid-air collision*. Master's thesis, Northern Arizona University, 113 pp.
- 2013 Picking up the pieces: Park Service management of the Grand Canyon disaster crash sites, 1956-2006. *In*: Quartaroli, Richard D. (compiler, ed.), *A rendezvous of Grand Canyon historians : ideas, arguments, and first-person accounts : proceedings of the Third Grand Canyon History Symposium, January 2012*. Flagstaff, Arizona: Grand Canyon Historical Society, pp. 203-206.

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- 2008 *1956 Grand Canyon mid-air collision crash sites : TWA-United Airlines : National Historic Landmark nomination*. [Flagstaff]: Northern Arizona University, History Department, 25 pp., 26 photos. ("A partnership project of Grand Canyon National Park; Ecological Monitoring and Assessment Program, Northern Arizona University; College of Engineering, Forestry, and Natural Sciences, Northern Arizona University".)

Cerretani, Anthony

- 2009 What are you afraid of? Haunted mountains? Vanished campers? Bloodthirsty creatures? An evil wind that lures hikers over a waterfall? We dare you to hike America's scariest trails. *Backpacker*, (November): 76-79. [See p. 77, "Tragedy in the Grand Canyon. When bodies can't be buried, do their spirits ever rest? Hike to the scene of this wreck and found out." Regarding 1956 air crash.]

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- 2009 System breakdown. *In: Mayday* [SERIES]. Cineflix. [Television broadcast series, episode 57. This episode, originally aired June 10, 2009, includes the 1956 Grand Canyon air crash.] [Later released on DVD.] 📺 📀 DVD-VIDEO
- 2012 Grand Canyon disaster. *In: Mayday* [SERIES]. Cineflix. [Television broadcast series, episode 91. This episode, originally aired January 24, 2013. 45:00.] [Later released on DVD.] 📺 📀 DVD-VIDEO

Conine, Ernest

- 1956 Russian roulette on our airways? *Harper's*, 213 (September): 40-45. [Includes references to the Grand Canyon mid-air collision.]

Corrigan, Daniel Ray

- 1980 *An empirical investigation of certain organizational climate influences on flying safety*. Doctoral dissertation, University of Arkansas, 277 pp. [Includes 1956 Grand Canyon crash.]

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- 1999 Hank Dirkmaat, '51-'85. *RUPAnews* (Retired United Pilots Association), 1(11) (December): 24-25. [Includes remarks on the 1956 Grand Canyon air crash. Dirkmaat was the boarding agent for the TWA flight in Los Angeles.]

Dubbs, Frank

- 1956 Statement of Capt. Frank Dubbs, Trans World Airline pilot. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, p. 129. [Relating to the 1956 Grand Canyon air crash.]

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- 2012 *Die Erschliessung der dritten Dimension : Entstehung und Entwicklung der zivilen Luftfahrtinfrastruktur in der Schweiz, 1919-1990*. Zürich: Chronos Verlag, 342 pp. (Verkehrsgeschichte Schweiz, Band 1

[Christian Rohr and Hans-Ulrich Scheidt, eds.].) [See pp. 193-194, regarding the 1956 air crash in Grand Canyon.]

[In German. *Title translated*: The development of the third dimension: emergence and development of civil aviation infrastructure in Switzerland, 1919-1990. *Series title translated*: Swiss Traffic History, Volume 1.]

Flexner, Stuart, AND Flexner, Davis

- 1992 *The pessimist's guide to history*. New York: Avon Books, 387 pp. [See item on 1956 air crash, p. 276.]

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- 1956 Statement of Dr. C. C. Furnas, Assistant Secretary of Defense, Research and Development, and Chairman, Air Navigation Development Board. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 293-316. [Relating to the 1956 Grand Canyon air crash.]

Garde aérienne suisse de sauvetage REGA [see also **Stünzi**]

- 2020 *REGA 2020 : avec Rapport annuel 2019*. Zurich-Aéroport: Garde aérienne suisse de sauvetage REGA, 40 pp. [including wraps]. [See "Dates clés" (pp. 24-25), which includes (p. 24), "1956. Aide d'urgence aux États-Unis. Après un accident d'avion dans une gorge inaccessible du Grand Canyon, des pionniers de la Garde aérienne suisse de sauvetage dégagent les corps sans vie de 128 passagers." (ENTIRE NOTE)]
- [In French. Citation translated: *REGA 2020: with Annual Report 2019*. Zurich Airport: Swiss Air Rescue REGA. See "Key dates". *Note translated*: "1956. Emergency aid to the United States. After a plane crash in an inaccessible gorge of the Grand Canyon, pioneers of the Swiss Air Rescue Guard extricate the lifeless bodies of 128 passengers."]

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- 1956 Statement of John A. Garrison, Chief, Facilities Operations Branch, Fourth Regional Office, Los Angeles, Calif., Civil Aeronautics Administration. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 30-39. [Relating to the 1956 Grand Canyon air crash.]

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- 2014 1956 crash site designated historic landmark; commemoration events June 30th and July 8th 2014. *The Bulletin* (Grand Canyon Historical Society), 18(3) (May/June): 1.

Greenquist, James C.

- 1956 Operation Granite Mountain. *U.S. Army Aviation Digest*, 2(10) (October): 5-9. [Recovery operation following the commercial aircraft crash in Grand Canyon.]

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- 1957 Fragmente aus dem tagebuch des jungen Teilnehmers am Jugendrothreuzlager in Oberhofen: Max Gribi (*transl.* 'Fragments from the diary of a young participant in the Red Cross youth camp in Oberhofen: Max Gribi'). *Das Schweizerische Rote Kreuz* (Bern), 66(7) (October 1): 9-12. [See in diary entry for July 27, 1957, note of film showing by Hax Hunziker of excerpts from Swiss Air Rescue Service films of rescue operations, including the recovery operation following the 1956 air crash in Grand Canyon. No details.] *[In German.]*

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- 1956 Statement of Capt. David Halperin, Chairman, TWA Air Safety Committee. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 104-116, 117-125. [Relating to the 1956 Grand Canyon air crash.]

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- 2005 *History of aviation safety oversight in the United States.* Berkeley, California: University of California at Berkeley, Institute of Transportation Studies, 64 pp. (Research Report NR-2005-001.) [Includes imprint, "NEXTOR, The National Center of Excellence For Aviation Operations Research".] [Grand Canyon air crash of 1956, see pp. vii, 18.]

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- 1957 [Remarks relating to the 1956 air crash in Grand Canyon.] *Congressional Record—House*, (July 1): 10706-10708. [Includes a reprinting of an article by Robert J. Serling in the *Washington Post* and the *Times-Herald* (Washington).]

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- 2013 *Légibalesetek pilótaszemmel III.* [No place]: Typotex. [See "Óriásgépek a Grand Canyon mélyén; 1956. június 30-án a Grand Canyon felett fényes nappal egymásnak ütközött a United Airlines DC-7-es és a TWA légitársaság Super Constellation típusú utasszállító repülőgépe", pp. 113-122. *[In Hungarian.* Citation translated: *Air accidents from a pilot's perspective III.* [No place]: Typotex. See "Giant Machines Deep in the Grand Canyon; On June 30, 1956, a United Airlines DC-7 and a TWA Super Constellation airliner collided in broad daylight over the Grand Canyon".]

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[Reprinting of U.S. Civil Aeronautics Board (1957).]

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- 2019 Tragedy over the Grand Canyon. *WanderAZ* (Northern Arizona Edition) (Phoenix), 4(13) (Summer): 26. [Historical summary of the 1956 air crash.]

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- 2021 *Havoc and reform : workplace disasters in modern America*. Baltimore, Maryland: Johns Hopkins University Press, 272 pp. [See Chapter 3, "Airliners Collide Over the Grand Canyon!" Primary focus is on airline employees as well as post-accident reforms.]

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- 2010 At the confluence of life and time. *Grand Canyon River Runner*, (10) (Summer): 6-7. [Visit to the 1956 crash site of a TWA Constellation airliner. Includes an excerpt from Katie Lee's river journal, July 13, 1956, ten days after the collision of the Constellation and a United DC 7 over Grand Canyon.] [Authors listed here as printed at head of article; at end of article authors are signed Martin and Lee.]

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- 2011 (ED.) *American aviation heritage : identifying and evaluating nationally significant properties in U.S. aviation history : a National Historic Landmarks theme study*. [Washington, D.C.]: U.S. Department of

the Interior, National Historic Landmarks Program, revised, 314 pp. (Produced by the National Historic Landmarks Program, Cultural Resources, National Park Service, U.S. Department of the Interior, Washington, D.C.; United States Air Force, Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio; and National Conference of State Historic Preservation Officers, Washington, D.C.) [Under "1920s Passenger Aircraft" (pp. 78-79), contemporary remarks on flight safety of the Ford Tri-Motor 4-AT in Grand Canyon. Also, regarding the 1956 air crash in Grand Canyon, brief remarks under "The Federal Aviation Act of 1958" (p. 208), and under "Properties Recommended for Further Study" is listed (p. 254) "Grand Canyon Crash Site, Grand Canyon National Park, Arizona" (no details).]

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- 1956 Statement of William S. MacNamara, Investigator, Bureau of Safety Investigation, Operations Group, Civil Aeronautics Board. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 24-30. [Relating to the 1956 Grand Canyon air crash.]

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- 1992 Final destination; the story of Flight 2 and Flight 718. *Airliners*, 5(1) (Spring): 41-46.

McComb, Michael B. [McComb, Mike]

- 2006 Desert disaster; TWA-United mid-air collision over the Grand Canyon. *America's Flyways*, 7(6) (June): cover, 1, 20-26.
- 2006 Collision over the canyon; half a century onward. *Airways*, 13(6) (August): 46-56.
- 2011 Collision over Mencius Temple: 25 years onward. *Airways*, 18(6): 40-46.
- 2025 Grand Canyon 1956 mid-air collision—What aviation archaeology reveals. *In: Spamer, Earle E. (ed.), Those Who Made a Difference : proceedings of the 6th Grand Canyon History Symposium, Grand Canyon, Arizona, November 1-4, 2023.* Grand Canyon, Arizona: Grand Canyon Conservancy, pp. 119-124.

McGivney, Annette, AND Smith, Mark

- 2016 June 30, 1956. *Arizona Highways*, 92(6) (June): 48-51. [Regarding the 1956 air crash in Grand Canyon.] [See also p. 3, "Contributors" section, regarding illustrator Mark Smith.] [See also letter from John R. Regnier, (9) (September): 4, which responds to and provides a correction to McGivney and Smith.]

Merrigan, William

- 1956 Statement of Capt. William Merrigan, Chairman, Master Executive Council, TWA Pilots Association. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 129-132. [Relating to the 1956 Grand Canyon air crash.]

Milner, Samuel, AND Garonzik, Joseph

- 1983 Thunder from the canyon; the birth of the FAA and a modern airways system. *World* (U.S. Federal Aviation Administration, Washington, D.C.), 13(8) (August): 4-10. [Features the event and aftermath of the 1956 Grand Canyon air crash.]

Nelson, Barbara, AND Nelson, Mike

- 2022 1956 midair collision 66th anniversary June 30th. *In: The Bulletin* [NEWSLETTER SECTION]. *The Ol' Pioneer* (Grand Canyon Historical Society), 33(2) (Spring): 19. [Announcement of commemorative events at Grand Canyon and Flagstaff.]

Nelson, Mike

- 2012 *We are going in : the story of the Grand Canyon disaster.* Bloomington, Indiana: AuthorHouse, 455 pp. [Aircraft disaster of 1956.] [An on-demand publication.]
- 2017 *We are going in : the story of the 1956 Grand Canyon midair collision.* Tucson: Rio Nuevo Publishers, 2nd ed., 455 [456] pp.
- 2020 New group: *Patrons of the 1956 Grand Canyon Midair Collision.* *In: The Bulletin* [NEWSLETTER SECTION]. *The Ol' Pioneer* (Grand Canyon Historical Society), 31(2) (Spring): 12-13. [Announcement.]

Novruzova, L. R.

- 2023 Keçmişdən günümüzə aviasiya qəzalarının səbəblərindəki dəyişikliklər. Changes in the causes of aviation accidents between the past and the present. *In: Quliyev, H. İ. [Guliyev, H. I.] (ed.), "Fevral məruzələri 2023: Aviakosmik məsələlərin həllində gənclərin yaradıcı potensialı" : VIII Beynəlxalq elmi-praktiki gənclər konfransının : Materialları : Bakı, Milli Aviasiya Akademiyası, 1-3 fevral 2023-cü il. : "Azərbaycan Hava Yolları" QSC-nin Poliqrafiya Mərkəzi / Proceedings of VIII International Scientific and Practical Youth Conference : "February Readings 2023 Creative Potential of the Youth in Solving of Aerospace Problems" : Baku, Azerbaijan, 1-3 February 2023 : Polygraphy Center of "Azerbaijan Airlines" CJSC.* [No imprint], pp. 286-288. [In Azerbaijani with bilingual article and volume titles.]

(Volume title-page with bilingual captions: *Azərbaycan Respublikası Elm və Təhsil Nazirliyi, "Azərbaycan Hava Yolları" QSC-nin Milli Aviasiya Akademiyası, Azərbaycan Respublikası Rəqəmsal İnkişaf və Nəqliyyat Nazirliyi, Azərbaycan Respublikasının Kosmik Agentliyi (Azərkosmos), Azərbaycan Mühəndislik Akademiyası / Ministry of Science [sic] and Education Republic of Azerbaijan, National Aviation Academy "Azerbaijan Airlines" CJSC, Ministry of Digital Development and Transport of the Republic of Azerbaijan, Azerbaijan Space Agency (Azerecosmos), Azerbaijan Engineering Academy.*)

[See p. 287 in section, "Təyyarə qəzalarına nümunələr" [*transl.* 'Examples of plane crashes'] (somewhat poorly composed; translation follows): "Təyyarələrin qəzaya uğraması müxtəlif səbəblərdən baş verir. Bu səbəblər bəzən insan, bəzən də texniki nasazlıq nəticəsində yaranı bilər. İnsan səhvlərindən yaranan təyyarə qəzaları özlüyündə olduqca müxtəlifdir. Məsələn, bəzən mədəni fərqliliklər, bəzən də dil problemləri qəzalara səbəb ola bilər. Texniki nasazlıqların səbəb olduğu qəzalar tamamilə fərqli səbəblərə əsaslanır. 1956-cı ildə bir DC-7 təyyarəsi və bir L1049 təyyarəsi

Amerikada Böyük Kanyon üzərində təxminən 20.000 fut yüksəklikdə bir ərazidə toqquşmuşdu və bu qəza 128 sərnəşinin ölümünə səbəb olmuşdu.” [transl. ‘Airplane crashes happen for a variety of reasons. These reasons can sometimes be caused by human and sometimes by technical failure. Aircraft accidents caused by human error are quite diverse in themselves. For example, sometimes cultural differences and sometimes language problems can cause accidents. Accidents caused by technical malfunctions are based on completely different reasons. In 1956, a DC-7 and an L1049 collided at about 20,000 feet above the Grand Canyon in America, killing 128 passengers.’]

Nuttall, Kern

- 2015 *In a better place : cemeteries and gravesites of Grand Canyon*. Flagstaff, Arizona: Vishnu Temple Press, 237 pp. [See also the selected guide to the Grand Canyon Pioneers Cemetery on a fold-out sheet by Cindy Stafford (2015).]

Oldham, Jennifer

- 2006 Historic disaster led to air traffic control system; in 1956, radarless airliners collided above Grand Canyon, killing 128 aboard. *Disasters Update* ([India] National Institute of Disaster Management), (347) (June 5): 3-5. [From *Los Angeles Times*, June 3, 2006.]

Ohlman, Jim

- 1994 The airline crash of 1956. *Grand Canyon Pioneers Society, Newsletter*, 5(4): 7.

Peterson, Arthur C.

- 1956 Statement of Arthur C. Peterson, Chief, Domestic Aviation Section, Forecasts and Synoptic Reports Division, United States Weather Bureau, Washington, D. C. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 135-144. [Relating to the 1956 Grand Canyon air crash.]

Pittman, Darrel

- 2013 Reminiscing FAA history. *North Dakota Aviation Quarterly* (North Dakota Aviation Council, Bismarck, North Dakota), 25(4) (Fall): 9. [Includes brief notice of the accident and aftermath of the 1956 aircraft collision in Grand Canyon, and brief note of the author’s station at Hill Air Force Base, Utah, while in the U.S. Air Force, and training with the Federal Aviation Administration at the Farmington (Utah) Sector of the Salt Lake City Center, requested because that sector encompasses the Grand Canyon.]

Preston, Edmund

- 1998 (ED.; WITH CONTRIBUTORS John R. Breihan, Arnold E. Briddon) *FAA historical chronology : civil aviation and the federal government, 1926-1996*. Washington, D.C.: U.S. Department of Transportation, Federal Aviation Administration, Office of Public Affairs, 2nd ed., 361 pp. [See p. 54, “Jun 30, 1956: A Trans World Airlines Super Constellation and a United Air Lines DC-7 collided over the Grand Canyon”.]

Prideaux, Michael

- 1975 (COMPILER) *Disaster*. London: Phoebus Publishing Co.
- 1976 (COMPILER) *World disasters*. Secaucus, New Jersey: Chartwell Books, Inc., in association with Phoebus, 128 pp. [See "The Grand Canyon Collision", pp. 56-57; regarding the 1956 air crash.]

Proctor, Jon

- 1989 TWA's Connies. *Airliners*, (Summer): 28-34. [Includes 1956 air crash.]
- 1991 Lest we forget. *Propliner*, (48): 41-42. [1956 air crash.]

Pyle, James T.; Thomas, David; Tippetts, Joseph; AND Davis, William

- 1956 Statements of James T. Pyle, Acting Administrator, Civil Aeronautics Administration; David Thomas, Director of Air Traffic Control Division; Joseph Tippetts, Director of the Office of Air Navigation Facilities; and William Davis, Director of the Office of Flight Operations and Airworthiness. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 199-237. [Relating to the 1956 Grand Canyon air crash.]

Pyle, James T.; White, Gerald F.; Tippetts, Joseph H.; Davis, William; Thomas, David D.; Meisel, Jay; AND Howell, Herbert H.

- 1956 Statements of James T. Pyle, Acting Administrator; Gerald F. White, Chief, Enforcement and Litigation, General Counsel's Office; Joseph H. Tippetts, Director, Office of Air Navigation Facilities; William Davis, Director, Office of Flight Operations and Airworthiness; David D. Thomas, Director, Office of Air Traffic Control; Jay Meisel, Personnel Officer, and Herbert H. Howell, Director of Airports, Civil Aeronautics Administration—resumed. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 238-257. [Relating to the 1956 Grand Canyon air crash.]

Quartaroli, Richard D.

- 2006 June 30, 1956 Grand Canyon mid-air collision—50th anniversary. *Boatman's Quarterly Review*, 19(2) (Summer): 47.

Ranney, Wayne

- 2014 58th anniversary Historic Landmark reception, June 30, 2014. *The Ol' Pioneer* (Grand Canyon Historical Society), 25(3) (Summer): 9-10. [Remarks read at the 58th anniversary commemoration of the 1956 Grand Canyon TWA-United Airlines aviation accident, with the attendance of victims' descendants and family.]
- 2014 Formal National Historic Landmark dedication, July 8, 2014. *The Ol' Pioneer* (Grand Canyon Historical Society), 25(3) (Summer): 11-12. [Remarks read to the dedication of the 1956 Grand Canyon TWA-United Airlines Aviation Accident Site as a National Historic Landmark.]

Rice, M. L.

- 1956 "We are going." *Lake Union Herald* (Seventh-day Adventists, Lake Union Conference, Berrien Springs, Michigan), 48(29) (July 17): 1. [Title quotation refers to the last radio message from a Union Air Lines DC-7 prior to crashing in Grand Canyon.]

Roosevelt, Eleanor

- 1956 *My Day* [syndicated newspaper column], (July 7). [Begins with thoughts on the recent (June 30) Grand Canyon disaster.]

Rossman, George, AND Allen, Richard

- 1963 (ED.-IN-CHARGE, AND ASSISTANT [for section]) Aeronautical law . . . collisions. *In*: What's New in the Law [SECTION]. *American Bar Association, Journal*, 49(4) (April): 372. [Regarding *Ahmann v. United Air Lines, Inc.*, United States Court of Appeals for the Eighth Circuit, February 6, 1963, Vogel, J.; respecting suit relating to the collision of two commercial airliners over Grand Canyon in 1956. Ellipsis is part of title.]

Rothschild, Louis S.

- 1956 Statement of Hon. Louis S. Rothschild, Under Secretary of Commerce, and Chairman, Air Coordinating Committee. *In*: *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 277-292. [Relating to the 1956 Grand Canyon air crash.]

Sayen, Clarence N.

- 1956 Statement of C. N. Sayen, President of the Air Line Pilots Association, Chicago, Ill. *In*: *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 52, 93-104. [Relating to the 1956 Grand Canyon air crash.]

Serling, Robert J.

- 1957 Canyon crash has made air safer. *Congressional Record—House*, (July 1): 10707-10708. [Regarding the 1956 air crash in Grand Canyon. Reprinted from the June 30 *Washington Post* and the *Times-Herald* (Washington).]

Shinsuke, Endō [遠藤信介 著]

- 2019 航空輸送100年：安全性向上の歩み. Tōkyō: 日本航空技術協会, 577 pp. [Includes 1956 Grand Canyon crash.]
[In Japanese. Citation in transliteration: Kōkū yūsō hyakunen anzensei kōjō no ayumi. Tōkyō: Nihonkōkū gijutsu kyōkai. Citation translated: 100 years of air transport : steps to improve safety. Tokyo: Japan Aviation Technology Association.]

Sleeth, George

- 1956 Statement of Capt. George Sleeth, Los Angeles Safety Committee. *In*: *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of*

Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956. Washington, D.C.: U.S. Government Printing Office, pp. 116-117. [Relating to the 1956 Grand Canyon air crash.]

Solomon, Jasper S.

- 1956 Statement of Capt. Jasper S. Solomon, a pilot for Trans World Airlines, Inc. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 52-78. [Relating to the 1956 Grand Canyon air crash.]

Speiser, Stuart M.

- 1956 Statement of Stuart M. Speiser, Chairman, Aviation Law Committee, National Association of Claimants' Compensation Attorneys. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 257-270. [Relating to the 1956 Grand Canyon air crash.]

Stafford, Cindy

- 2015 *In a better place: At rest in Grand Canyon Cemetery : a guide to pioneers, Harvey Girls, National Park Service, scholars, community members, veterans, and the 1956 airline crash memorial.* Flagstaff, Arizona: Vishnu Temple Press, large folded brochure, 1 sheet. [See also the comprehensive book by Kern Nuttall (2016).]

Stephan, Lionel

- 1956 Statement of Capt. Lionel Stephan, pilot for American Airlines. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956.* Washington, D.C.: U.S. Government Printing Office, pp. 78-92. [Relating to the 1956 Grand Canyon air crash.]

Stünzi, Walter [see also **Garde aérienne suisse de sauvetage REGA**]

NOTE: The three citations from 2006 are from the French, German, and Italian editions of *1414*, the serial produced in Zurich by REGA, the Swiss Air Rescue Guard (cited here with the trilingual organizational name). Each title translates approximately as "In the hell of the Grand Canyon; memories of a major operation 50 years ago". Regarding the Swiss mountaineer rescue team at the 1956 United Airline crash site in Grand Canyon.

- 2006 Dans l'enfer du Grand Canyon; cinquantenaire d'une intervention spectaculaire. *1414* (REGA: Schweizerische Rettungsflugwacht/Garde Aérienne Suisse de Sauvetage/Guardia Aerea Svizzera di Salvataggio) (Zurich) [French ed.], (67) (November): 28-29, 31. *[In French.]*
- 2006 In der Hölle des Grand Canyon; erinnerungen an einen Grosseinsatz vor 50 Jahren. *1414* (REGA: Schweizerische Rettungsflugwacht/Garde Aérienne Suisse de Sauvetage/Guardia Aerea Svizzera di Salvataggio) (Zurich) [German ed.], (67) (November): 28-29, 31. *[In German.]*

- 2006 Nell'inferno del Gran Canyon; ricordi di un intervento maggiore di 50 anni fa. *1414* (REGA: Schweizerische Rettungsflugwacht/Garde Aérienne Suisse de Sauvetage/Guardia Aerea Svizzera di Salvataggio) (Zurich) [Italian ed.], (67) (November): 28-29, 31. [In Italian.]
- 2007 Dans l'enfer du Grand Canyon; cinquantenaire d'une intervention spectaculaire de la Garde Aérienne Suisse de Sauvetage. *LAR Report* (Luxembourg Air Rescue A.s.b.l.), (April): 24-25. [In French. Title translated: In the hell of the Grand Canyon; memories of a major operation 50 years ago of the Swiss Air Rescue Guard.]

Sulpizio, Tom

- 2025 The 15 technologists of United Flight 718—Some of the nation's leading technologists perished on Chuar Butte on June 30, 1956. *In*: Spamer, Earle E. (ed.), *Those Who Made a Difference : proceedings of the 6th Grand Canyon History Symposium, Grand Canyon, Arizona, November 1-4, 2023*. Grand Canyon, Arizona: Grand Canyon Conservancy, pp. 109-118.

Summers, Fred

- 1956 Statement of Fred Summers, Air Transport Division, Transport Workers Union, AFL-CIO. *In*: *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 271-276. [Relating to the 1956 Grand Canyon air crash.]

Taneja, Narinder, AND Wiegmann, Douglas A.

- 2001 Analysis of mid-air collisions in civil aviation. *In*: *Proceedings of the 45th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA*. [Includes reference to 1956 Grand Canyon air crash.]

Taylor, Maxwell D.

- 1956 *General Orders No. 39. Soldier's Medal—Awards. Commendation Ribbon with Metal Pendant—Awards*. Washington, D.C.: U.S. Army, The Adjutant General's Office, 4 pp. (TAGO 1085B—Aug. 40478°—56.) [Medals awarded to U.S. Army officers relating to service in the Grand Canyon following the June 1956 crash of two commercial airliners.] [Gen. Maxwell D. Taylor, U.S. Army, Chief of Staff, by order of Wilber M. Brucker, Secretary of the Army (by direction of the President). Official: Maj. Gen. John A. Klein, U.S. Army, The Adjutant General.]

Timmerman, Craig F.

- 1956 Statement of Craig F. Timmerman, Air Transport Association. *In*: *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 336-343. [Relating to the 1956 Grand Canyon air crash.]

U.S. Civil Aeronautics Board

NO DATE *SA-320/File No. 1-0090. Adopted: April 1957—Released: April 17, 1957. Civil Aeronautics Board : Accident Investigation Report : midair collision, Trans World Airlines Lockheed L-1049A N6902C, United Air Lines Douglas DC-7 N6324C over Grand Canon, Arizona, June 30, 1956. Converse, Texas: AIREPORTS, 32 pp. + 4 leaves illustrations. (TW1.) [Transcription copyright AIREPORTS. Completely reset with justified margins. Cover sheet: Civil Aeronautics Board Accident Investigation Report : midair collision : Trans World Airlines L-1049A N6902C, United Air Lines DC-7 N6324C over Grand Canyon, Arizona, June 30, 1956.]*

1957 *Trans World Airlines, Inc., Lockheed 1049A, N 6902C, and United Air Lines, Inc., Douglas DC-7, N 6324C, Grand Canyon, Arizona, June 30, 1956. U.S. Civil Aeronautics Board, Accident Investigation Report SA-320, File No. 1-0090, adopted April 15, 1957, released April 17, 1957. [Report prepared by James R. Durfee, Chan Gurney, Harmar D. Denny, and G. Joseph Minetti (as noted on last page of text, which also notes, "Member Louis J. Hector did not take part in the adoption of the report.")]*

NOTE: Two variants have been seen; both mimeographed:

Variant 1, with p. 1 displaying typewritten series title, "C I V I L A E R O N A U T I C S B O A R D A C C I D E N T I N V E S T I G A T I O N R E P O R T", thus; text 53 pp. typed 1½-spaced, [4]-p. illustrations, "Supplemental Data" paginated i-v.

Variant 2, with p. 1 displaying block-lettered series title, "CIVIL AERONAUTICS BOARD ACCIDENT INVESTIGATION REPORT", in non-bold and bold type, thus; text 25 pp. typed single-spaced, with "Supplemental Data" paginated i-iii, and [4]-p. illustrations.

Although both variants employ monospaced characters, *Variant 2* is typed with a more condensed character spacing than as used in *Variant 1*. The timing of these states is undetermined here. Also undetermined here is the faithfulness of texts to each other, although they seem to be identical.

[Variant 2 is reproduced in facsimile in the Appendix of the present volume.]

1957 *Annual report of the Civil Aeronautics Board : 1957. Washington, D.C.: U.S. Government Printing Office, 44 pp. [See "Grand Canyon collision", p. 27.]*

U.S. House of Representatives, Committee on Interstate and Foreign Commerce, Subcommittee

1956 *Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956. Washington, D.C.: U.S. Government Printing Office, 343 pp. [Relating to the 1956 Grand Canyon air crash. Remarks by individuals are separately cited throughout this bibliography.]*

U.S. National Park Service, Director [Wirth, Conrad L.]

1957 *Annual report of the Director, National Park Service, to the Secretary of the Interior : reprinted from the Annual Report of the Secretary of the Interior for the Fiscal Year ended June 30, 1957. [No imprint]. [See "Catastrophe" (p. 316), regarding the 1956 air crash in Grand Canyon.]*

U.S. National Park Service, Intermountain Region, Heritage Partnerships Program

[2012?] *Arizona. U.S. National Park Service, Intermountain Region, Heritage Partnerships Program, 6 pp. [Undated. Includes a project pertaining to the 1956 Grand Canyon TWA-United Airlines Mid-Air Collision Site National Historic Landmark nomination (Grand Canyon).]*

U.S. National Park Service, National Register of Historic Places

- 2014 1956 *Grand Canyon TWA–United Airlines Aviation Accident Site*. National Historic Landmark nomination; Grand Canyon National Park Archaeological Site AZ:C:13:07555). [Nomination prepared February 10, 2011; Ian Hough, Grand Canyon, Arizona; Benjamin Carver, Flagstaff, Arizona; Susan Ciani Salvatore, Washington, D.C. (Alexandra Lord and Susan Ciani Salvatore, eds.). *Summary*: “The 1956 Grand Canyon United-TWA Aviation Accident Site meets National Historic Landmark Criterion 1 for its association with the modernization of America’s aviation airways. On June 30, 1956, a Trans World Airlines Super Constellation L-1049 and a United Air Lines DC-7 collided in uncongested airspace 21,000 feet over the Grand Canyon in Arizona, killing all 128 people onboard the two flights. Regarded as an important watershed in aviation history, the accident dramatically accelerated movements to address an airway crisis created by improved aircraft technology, the advent of the jet age, increasing traffic in the airspace system, and the fact that little had been done to expand the capacity of the air traffic control system. As a result, in August 1957 President Eisenhower signed the Airways Modernization Act, a prelude to establishing the Federal Aviation Agency.”] ***[The redacted version of the nomination form is reproduced in facsimile in the Appendix of the present volume.]***

Warren, Ronald L. [Warren, Ron]

- 1993 Toll restricted. *Grand Canyon Pioneers Society, Newsletter*, 4(8): 5. [Pertaining to telephones in use at Red Butte and Tusayan during the recovery operations of the 1956 air crash in Canyon.]
- 1994 [Letter regarding 1956 air crash.] *Grand Canyon Pioneers Society, Newsletter*, 5(5): 7-8.

White, Gerald F.

- 1956 Statement of Gerald F. White, Office of the General Counsel, Civil Aeronautics Administration, Washington, D. C. *In: Airspace use study : hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Eighty-fourth Congress, Second Session, on use of airspace : July 7, 18, September 11, 12, and 13, 1956*. Washington, D.C.: U.S. Government Printing Office, pp. 48-50. [Relating to the 1956 Grand Canyon air crash.]
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Coverage in *The New York Times*

The New York Times was selected for bibliographical coverage of Grand Canyon–Colorado River items at the time when the original bibliography was begun, in 1974. Access in those days was only through hardcopy collections or through microfilms; thus there was a perceived need to cite material from this newspaper, which spanned the entire history of the canyon and river from the mid-1800s. Today, *The New York Times* is accessible through search screens online at <https://nytimes.com>; most if not all of the items cited here may be examined in facsimile images and downloaded as PDFs. (An online subscription may be needed.) Paginations generally refer to the City Edition of the paper. The citations as displayed in this bibliography thus may not perfectly represent a particular copy of the paper seen by a researcher, or for that matter a copy on *The Times*' website. Some reordering of articles on different pages between the day's editions, the result of the daily work of the editors of *The Times*, may be discovered in one's own research.

Reading through the citations here offers a detailed perspective of a national/international newspaper's coverage of the accident and its aftermath, usually in greater overall breadth than that which may appear in more local papers. The citations are in chronological order.

- 1956 (July 1) Two airliners carrying 128 vanish in West; wreckage of one sighted in Grand Canyon. No sign of life. 70 on crashed T.W.A. plane — United craft is still missing. (pp. 1, 42)
- 1956 (July 1) Record toll seen for air disaster. Total of 128 deaths in two missing planes will exceed 1950 Wales crash by 48. (p. 42)
- 1956 (July 1) List of those on two planes. (p. 42) [See also revised list, July 2.]
- 1956 (July 2) All 128 on 2 airliners found dead; craft presumed to have collided before crashing in Grand Canyon. 'Copter at scene. Plans are laid to fly out victims' bodies—Inquiry starts. (pp. 1, 14)
- 1956 (July 2) C.A.A. scans logs for clue to crash. Official says radio reports by pilots will be studied—T.W.A. changed altitude. (pp. 1, 14)
- 1956 (July 2) No large pieces of craft sighted. Charred rock on knoll with bits of metal and paint only remains of DC-7. Bodies are not visible. 3 in helicopter see wrecks about a mile apart—Some debris buried. (p. 14)
- 1956 (July 2) Sketches of victims in the air crash. (p. 14)
- 1956 (July 2) U.S. seeks to end collision hazard. 5-year program attempts to improve traffic in air—"Urgent action" asked. (p. 14)
- 1956 (July 2) "It can't happen to you". Pilot in crash called plane safe if it flew on course. (p. 14)
- 1956 (July 2) California victims were on vacations. (p. 14)

- 1956 (July 2) St. Patrick's worshipers pray for crash victims. (p. 14)
- 1956 (July 2) 2 airliners fell in a wilderness. Region a tangle of canyons and buttes visited only rarely by tourists. (p. 15)
- 1956 (July 2) List of dead on 2 planes. (p. 15) [Revised list.]
- 1956 (July 2) 128 death toll makes airline mishap worst. (p. 15)
- 1956 (July 2) Two lines offer to fly relatives to crash area. (p. 15)
- 1956 (July 2) Plane's last message was "We are going—". (p. 15)
- 1956 (July 2) London paper shows canyon. (p. 15)
- 1956 (July 2) Crash deaths mark first for a DC-7. (p. 15)
- 1956 (July 2) Plane crash detective. William Kossuth Andrews. (p. 15) [Director, Civil Aeronautics Board, Bureau of Safety Investigation.]
- 1956 (July 2) When the averages fail. [Editorial.] (p. 20)
- 1956 (July 3) Removal of air victims starts; wreckage in canyon is studied. By **Gladwin Hill**. (pp. 1, 12)
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Civil Aeronautics Board Accident Investigation Report

American Aviation Heritage National Historic Landmark Report

National Historic Landmark Nomination (redacted version)

Civil Aeronautics Board Accident Investigation Report

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: April 15, 1957

Released: April 17, 1957

TRANS WORLD AIRLINES, INC., LOCKHEED 1049A, N 6902C, AND
UNITED AIR LINES, INC., DOUGLAS DC-7, N 6324C,
GRAND CANYON, ARIZONA, JUNE 30, 1956

The Accident

At approximately 1031^{1/} June 30, 1956, a Trans World Airlines Lockheed 1049A, N 6902C, and a United Air Lines Douglas DC-7, N 6324C, collided at about 21,000 feet^{2/} over Grand Canyon, Arizona. Both aircraft fell into the Canyon near the confluence of the Colorado and Little Colorado Rivers. There were no survivors among the 128 persons aboard the flights (70 aboard TWA and 58 aboard United). Both aircraft were destroyed.

History of the Flights (See attachment 1 as reference.)1. Trans World Airlines

On June 30, 1956, at 0901, Trans World Airlines Flight 2, a regularly scheduled passenger service, took off from runway 25 of the Los Angeles International Airport. Flight 2 was on an instrument flight rules (IFR) flight plan from Los Angeles, California, to Kansas City, Missouri, via Green Airway 5, Amber Airway 2, Daggett direct Trinidad, direct Dodge City, Victor Airway 10 Kansas City. The flight plan also proposed a cruising altitude of 19,000 feet, a true airspeed of 270 knots, and a departure time of 0830. The Trans World flight crew consisted of Captain Jack S. Gandy, Copilot James H. Ritner, Flight Engineer Forrest D. Breyfogle, Flight Engineer Harry H. Allen (aboard as an additional crew member), and Hostesses Tracine E. Armbruster and Beth E. Davis.

Preparations for Flight 2 were routine except that departure was delayed a few minutes by minor maintenance on the aircraft. The flight was dispatched with 3,300 gallons of fuel and the load manifest showed the gross weight of the aircraft at takeoff was 108,115 pounds, well under the maximum allowable of 113,200 pounds. The load was properly distributed with respect to center of gravity limitations of the aircraft.

1/ Times herein are Pacific standard and based on the 24-hour clock.

2/ Altitudes herein are mean sea level, distances are nautical miles unless otherwise indicated.

As requested, the flight, after takeoff, contacted the Los Angeles tower radar departure controller, and was vectored through an overcast which existed in the Los Angeles area. After reporting "on top" (2,400 feet) the flight switched to Los Angeles Air Route Traffic Control Center (referred to as Los Angeles Center) frequency, 118.9 mcs., for its en route clearance. This clearance specified the routing as filed in the flight plan, however, the controller specified that the flight climb to 19,000 feet in VFR conditions. Immediately thereafter TWA 2 asked for a routing change to Daggett via Victor Airway 210. This was approved in a routine manner.

At 0921, through company radio communications, Flight 2 reported that it was approaching Daggett and requested a change in flight plan altitude assignment from 19,000 to 21,000 feet. ARTC (Los Angeles Center) advised they were unable to approve the requested altitude because of traffic (United Air Lines Flight 718). Flight 2 requested a clearance of 1,000 feet on top. Ascertaining from the radio operator that the flight was then at least 1,000 on top, ARTC cleared the flight.

At 0959 Trans World 2 reported its position through company radio at Las Vegas. It reported that it had passed Lake Mohave at 0955, was 1,000 on top at 21,000 feet, and estimated it would reach the 321-degree radial of the Winslow omni range station (Painted Desert) at 1031 with Farmington next. This was the last radio communication with the flight.

2. United Air Lines

United Air Lines Flight 718 was regularly scheduled from Los Angeles to Chicago, Illinois. On June 30, 1956, it took off from runway 25L (left) of the Los Angeles International Airport at 0904 (three minutes after TWA 2). Flight 718 was on an IFR flight plan to Chicago via Green Airway 5 Palm Springs intersection, direct Needles, direct Painted Desert, direct Durango, direct Pueblo, direct St. Joseph, Victor Airway 116 Joliet, Victor Airway 84 Chicago Midway Airport. The flight plan proposed a true airspeed of 288 knots, a cruising altitude of 21,000 feet, and a departure time of 0845. The flight crew consisted of Captain Robert F. Shirley, First Officer Robert W. Harms, Flight Engineer Gerard Fiore, and Stewardesses Nancy L. Kemnitz and Margaret A. Shoudt.

Flight preparations and dispatch of United 718 were routine and the aircraft departed with 3,850 gallons of fuel. The company load manifest showed the gross weight of the aircraft at takeoff to be 105,835 pounds, which was less than the maximum allowable of 114,060 pounds; the latter weight was restricted from a maximum of 122,200 pounds for the aircraft because of a landing limitation at Chicago. The load was properly distributed with respect to the center of gravity limitations of the aircraft.

After takeoff the flight contacted the Los Angeles tower radar controller, who vectored it through the overcast over the same departure course as TWA 2. United 718 reported "on top" and changed to Los Angeles Center frequency for its en route clearance. This corresponded to the flight plan as filed; however, the controller specified that the climb to assigned altitude be in VFR conditions.

Flight 718 made position reports to Aeronautical Radio, Inc., which serves under contract as United company radio. It reported passing over Riverside and later over Palm Springs intersection. The latter report indicated that United 718 was still climbing to 21,000 and estimated it would reach Needles at 1000 and the Painted Desert at 1034.

At approximately 0958 United 718 made a position report to the CAA communications station located at Needles. This report stated that the flight was over Needles at 0958, at 21,000 feet, and estimated the Painted Desert at 1031, with Durango next.

At 1031 an unidentified radio transmission was heard by Aeronautical Radio communicators at Salt Lake City and San Francisco. They were not able to understand the message when it was received but it was later determined by playing back the recorded transmission that the message was from United 718. Context was interpreted as: "Salt Lake, United 718 . . . ah . . . we're going in."

Investigation

When neither flight reported passing the Painted Desert line of position, CAA and company ground communications attempted to contact them. This was unsuccessful and a radio search was then made by several communications stations along the proposed routes, using numerous radio frequencies available to the flights. At 1151 a missing aircraft alert was issued, followed by implementation of search and rescue procedures.

That evening a pilot who operated scenic flights over the Grand Canyon heard about the missing aircraft and recalled having seen light smoke rising out of the Canyon earlier in the day. With his brother, he returned to the area, flew into the Canyon, and during a low pass was able to identify the empennage of the TWA Constellation. He reported the finding immediately and the next day made another flight, during which it was ascertained that there was a second wreckage approximately one mile from the first. There were no signs of survivors on either occasion.

On July 1 an Air Force helicopter from a Search and Rescue unit landed, under hazardous conditions, at the TWA site. After careful consideration, planning, and trial flights, a successful landing was made by an Army helicopter pilot at the United wreckage. On both initial landings a medic accompanied the helicopter pilot and, after examination, reported that no one had survived either crash. During the following days Army units provided transportation, under extremely hazardous conditions, to and from the sites by helicopter, making it possible to reach the otherwise nearly inaccessible area.

The L-1049 Constellation crashed in a draw on the northeast slope of Temple Butte, which is on the west bank of the Colorado River within the Grand Canyon. The main wreckage site was at an elevation of 3,400 feet. The wreckage was found strewn across the draw along a southwesterly heading,

with portions of the nose section on the south bank of the draw and sections of the cabin fuselage on the north bank. A relatively short wreckage distribution path showed that the aircraft contacted the ground at a steep angle. The distribution and condition of parts indicated the Constellation was inverted at initial impact.

Severe disintegration of the L-1049 occurred during ground impact, followed by an intense ground fire. Together, these caused nearly total destruction of major portions of the aircraft. It was possible, however, to identify a sufficient number of parts to show that with the exception of the L-1049 empennage, portions of the aft fuselage, and light pieces of aft cabin interior, all of the aircraft was at the main wreckage area. Here several pieces of the DC-7 were located. All of these were identified as being parts of the DC-7 left outer wing structure.

The main wreckage area of the DC-7 was located 1.2 statute miles northeast of the L-1049 area. Examination revealed the DC-7 struck the south face of Chuar Butte opposite the Little Colorado River. Impact was about 10 feet below the top of this ridge at an elevation of 4,050 feet. Initial impact was on a northeast heading with the aircraft nosed down and its right wing below a level attitude.

Impact forces caused severe disintegration of the DC-7 with major components falling into an inaccessible deep chimney and upon sheer ledges below the impact site. An intense ground fire followed impact. Except for a large portion of its left wing, the DC-7 major components were accounted for by identification of parts and pieces found at or reasonably near the main wreckage area.

During the difficult and hazardous structural investigation every effort was made to determine whether or not an inflight collision had occurred and, if so, the manner in which the aircraft collided. Results of this work disclosed several areas of damage which conclusively established that such collision did occur. These areas also provided material for an analytical study relating to the physical relationship of the aircraft to each other at the instant of the inflight impact.

One of the significant areas involved in the inflight contact was the left outer wing panel of the DC-7. Pieces found represented the wing panel from its tip inboard to station 453, a length of about 20 feet. Much of this structure bore evidence of the inflight collision. Some portions of the upper surface, leading edge, and aileron were missing.

The largest single piece of left wing outer panel was found between Temple and Chuar Buttes about one-third mile west of the TWA wreckage site. This piece consisted of the outer portion of the panel from the tip inboard to approximately station 627. To this station the upper and lower wing skin and the leading edge were generally intact. Portions of lower skin were in place for another six feet inboard. Collision evidence in the form of dents, scratches, tears, and bends were found on much of the lower surface of this

entire structure. Part of this damage consisted of an upward and inboard deformation in the wing tip cap between the position light and aileron cove. Black rubber smears and red paint smudges were evident at several locations in the deformation. Examination showed the smears on the DC-7 were from the L-1049 deicer boot; also, the paint smudges were from the L-1049.

A fragment of DC-7 wing tip assembly was found separately. This 11-inch piece was part of the aileron cove from the extreme wing tip area. Fragments of top and bottom wing skin were still attached to this piece. Just aft of the tear the tip radius was deformed inboard, rearward, and upward with heavy deposits of L-1049 red paint in the crumpled area. Further, the tip lower surface inboard to the tip attach point was deformed upward and marked by scratches running inboard and aft. Also, in this general area on the lower wing surface there were numerous black rubber smears and additional scratches. The smears and scratches ran diagonally aft and inboard about 23 degrees in relation to the wing center spar line.

Two pieces of the DC-7 left aileron were found representing the tip area inboard to about station 656. These pieces were severely buckled inboard and upward and both bore heavy deposits of black rubber smears on their lower surfaces.

Between stations 627 and 603 the wing leading edge of the DC-7 was deformed rearward and outboard. Rearward and inboard scratches on the lower leading edge were continuous through areas of deep buckling, indicating they were made before the leading edge struck the object causing buckling. Aft of the leading edge on the lower wing surface there were more scratches running aft and inboard at an angle of approximately 25 degrees relative to the center spar. In this specific area there was no evidence of the black rubber smears.

At the L-1049 wreckage area a section of lower wing skin from the DC-7 was found. This section was from the left wing where the aircraft registration is painted and bore portions of numbers "6" and "3." Scrape marks corresponded directionally to those previously described. Imbedded in a tear on this part was a piece of Constellation headlining used in the aft cabin ceiling. Brown smudges running in the same general direction as the scratches were determined by chemical analysis to be material used to seal Constellation fuselage seams and stringers in the pressure cabin area.

A second area of damage significant to the investigatory objectives and closely allied with the DC-7 wing damage was the Constellation empennage. This major component had struck the ground inverted but came to rest in an upright position about 550 yards north of the concentration of L-1049 wreckage. It was generally intact except for the left and right fins and rudders. Respectively, these were found about 30 and 10 yards removed. The distance of the empennage from the rest of the L-1049, together with the evidence of severe damage where it was separated from the aft fuselage, showed this major component had separated in flight after collision impact. Heavier pieces of the L-1049 aft fuselage structure and aft interior equipment were found west of

the main TWA wreckage site. Light interior materials from the aft fuselage were found on Cape Solitude 1-1/2 miles east, indicating that they were torn or spilled out at a sufficient altitude to drift this distance.

Two pieces from the Constellation empennage were recovered away from the main empennage at sufficient distance to indicate separation prior to ground impact. These, consisting of sections of the left upper fin leading edge and bearing portions of red and white stripes of the Constellation color scheme, showed collision evidence. One piece was concaved on its leading edge, in the area of the red stripe, by an object moving right to left. The concave area fitted precisely with the damage on the DC-7 left wing tip. The red paint found on the wing tip came from this red stripe, and the black marks resulted from contact with the fin leading edge deicer boot. The second piece, which fitted below the concaved piece, was crumpled to the left by the same force that damaged the concaved piece.

The L-1049 aft fuselage was a third area of collision damage. Most significant was a piece of fuselage skin about 1-1/2 x 4 feet in size. Identification showed it came from the upper right side of the Constellation fuselage just forward of the tail. Its outer surface was painted white. This metal piece was bent inward about 90 degrees so that its inner surfaces were folded toward each other. There were red, blue, and black marks in various directions on the white outer surface paint in the area aft of the bend. In addition to these marks there were gray deposits in a random pattern creating a stippled effect over the entire surface. Together with these there were also long grayish smears progressing in the same direction as the stippling. Pileup of the individual marks within the deposits was heavier on the upper edge. This evidence indicated that the gray deposits were made by an object moving up and along the circumferential frames of the Constellation fuselage.

The final area of important damage was also in the aft fuselage of the L-1049. It was a series of three propeller cuts in the lower and bottom fuselage in the vicinity of the rear baggage compartment. The cuts were generally upward and inboard and of varying lengths. They were essentially parallel about 35 inches apart with the middle cut about 52 degrees relative to the longitudinal axis of the aircraft. Red and blue paint marks at the edge of one cut in the baggage bin area coincided with the paint scheme on the DC-7 propeller.

Two additional propeller cuts were located in the L-1049 forward fuselage. One cut was approximately in line with the L-1049 No. 3 propeller arc and the other was about four feet forward. This damage was not consistent with the other collision damage and the cuts were probably made by the propeller of the Constellation during ground breakup.

Other areas of both aircraft were involved in the collision. Some were secondary or cumulative to the evidence already described and others, although important for other reasons, were not indicative of the inflight impact.

Investigation showed that normal and routine preparations were made for the flights. The TWA Constellation had received a periodic maintenance check at Los Angeles and except for minor discrepancies, not affecting airworthiness, was in good condition. The DC-7 was checked at Los Angeles and at departure there were no mechanical discrepancies or carryover items. The flight engineers had performed preflight and walkaround inspections of their respective aircraft.

Both flights were planned as high-altitude operations (above 14,500 feet west of the 100-degree Meridian) which under current regulations and operating specifications permitted them to be planned and flown off airways over direct courses to take advantage of the most favorable weather and wind factors as well as the shortest distance between origin and destination of the long-range nonstop flights. Before flight, however, a definite flight plan is required over the direct route with numerous reporting points indicated to clearly define the proposed route to be flown. To this end numerous company high-altitude routes have been established. From these the most favorable is selected for an individual operation commensurate with existing conditions.

United Airlines' operational policy permitted a high-altitude flight to be conducted on an IFR or VFR flight plan but the company did not permit its flights to be flown in instrument weather conditions, regardless of the flight plan, during that portion of the flight off airways. In this regard Trans World Airlines' policy, at the time of the accident, permitted off airways flights in instrument weather conditions but only on an IFR flight plan with an assigned altitude. When operating 1,000 on top the company required adherence to visual flight rules.

The pilots were briefed on the anticipated weather conditions before flight time. These indicated conditions well within limits for takeoff and for the planned duration of the flights. Captain Gandy, with nearly 15,000 flying hours, had flown the subject route approximately 177 times and was well qualified. Captain Shirley, with 17,000 hours, had flown the operation since October 1955, and he also was well qualified. Similarly, the other crew members of both flights were experienced. All, according to documentary evidence, were rested, in good physical condition, currently qualified, and certificated for their positions.

The flights reported in a normal manner as they progressed eastward. Except for the final transmission of United 718, the reports were without indication of any difficulty. The individual company dispatch offices followed the progress of their flight in a regular manner according to their responsibility.

Approaching Daggett the TWA flight asked for a change in its flight altitude from 19,000 feet to 21,000 feet on its IFR clearance, and if unable, 1,000 on top. The TWA radio operator who received this request from the flight called Los Angeles ARTC and at 0921 advised, "TWA 2 is coming up on Daggett requesting 21,000 feet." The Los Angeles controller then contacted the Salt

Lake ARTC controller and said, "TWA 2 is requesting two one thousand, how does it look? I see he is Daggett direct Trinidad, I see you have United 718 crossing his altitude - in his way at two one thousand." According to the recording of this conversation the Salt Lake controller replied, "Yes, their courses cross and they are right together." The Los Angeles controller then called the TWA radio operator and said, "Advisory, TWA 2, unable approve two one thousand." At this time the radio operator interrupted and said, "Just a minute. I think he wants a thousand on top, yes a thousand on top until he can get it." After determining from the flight, through the TWA radio operator, that it was then 1,000 on top the Los Angeles controller issued the following amended clearance, "ATC clears TWA 2, maintain at least 1,000 on top. Advise TWA 2 his traffic is United 718, direct Durango, estimating Needles at 0957." The TWA ground radio operator stated that this clearance was given TWA 2 and it was repeated back to him verbatim by the flight. The operator said that in this transmission he included the information concerning United 718, adding that it was at 21,000 feet which he concluded from the overall situation although the altitude was not part of the information from the controller. The TWA operator testified that he recognized Captain Gandy's voice and that the captain acknowledged the information on the United flight as "traffic received."

The two controllers participating in this action were called to testify at the Board's public hearing. In response to questions they stated that because TWA 2 would soon pass from the Los Angeles ARTC area of responsibility to the Salt Lake area it was necessary to coordinate the TWA request for altitude change. Both stated that at this time the flights were IFR traffic operating in controlled airspace and ARTC was required to separate them from each other as well as from any other aircraft on IFR clearances. The controller who gave the clearance said he offered the United Information to TWA merely as an explanation for the denial of 21,000 and not as a traffic advisory.

The Director of the CAA Office of Air Traffic Control explained that when TWA requested 21,000 feet the flight had not reached Daggett nor had the United flight reached Needles. They were not traffic for each other at that time but in projecting their tracks eastward both would cross Red Airway 15 with ill-defined horizontal separation. On this airway ARTC was required to separate the flights; thus TWA was denied 21,000. The witness added that this separation was an ARTC responsibility for instrument flights only in the controlled airspace and that Red Airway 15 was the last such area for the flights to traverse until they were well beyond the accident scene. He said that ARTC maintains only progress information with respect to IFR flights flying through uncontrolled airspace and that this information is used for the purpose of providing a safely spaced flow of instrument traffic into the next controlled airspace to be entered. He stated that air traffic control does not provide any control service or function in uncontrolled airspace. The witness explained that flights are not bound by clearance or flight plan, whether VFR or IFR, while operating in uncontrolled airspace and that instrument traffic must only leave and reenter a control area according to traffic control clearance. The controllers' manual of control procedures (ANC Manual) states that, "Clearances authorize flight within control zones and control areas only; no responsibility for separation of aircraft outside these areas is accepted."

When TWA amended its flight plan from an assigned 19,000 feet to 1,000 feet on top, no information concerning this was given to United 718. The Director of Air Traffic Control stated that none was required though the flights were in controlled airspace at the time. The clearance to TWA 2 was to maintain 1,000 feet on top while it was in a control area. The witness said the flight was not restricted to any specific altitude in control areas except that it be at least 1,000 feet above the general cloud layer. When outside controlled airspace and under certain conditions of limited visibility flight should be conducted at an altitude conforming to the "Quadrantal Rule."^{3/} The witness stated that the controller therefore did not know what altitude Captain Gandy would select as a cruising altitude or if he might later change the altitude from time to time. The witness stated that with respect to separation the TWA flight at this time was a VFR flight and that the basic VFR minimums applied for it to maintain flight in VFR conditions.^{4/}

Civil Air Regulations do not provide a definition for 1,000 on-top operation either within or outside controlled airspace; however, with respect to on-top operations in control areas the Flight Information Manual states, "'At least 1000 feet on top' (LOTOP) may be filed in an IFR flight plan, or assigned by ATC in an IFR clearance, in lieu of a cruising altitude. Even though this type of operation places the responsibility for avoidance of collision with other aircraft on the pilot, the flight is an IFR operation and must obtain an amended clearance for a specific altitude before proceeding into IFR weather conditions." It further states, "Air Traffic clearances which specify 'at least 1000 feet above all clouds' in lieu of a cruising altitude permits flight to be conducted at any altitude at or above the minimum en route altitude (MEA) which is 1000 feet or more above the cloud layer"

The present concept for separation of aircraft and avoidance of collision in VFR weather conditions, regardless of flight plan or clearance, depends on the flight crews' ability to visually provide separation between aircraft. Civil Air Regulations expressly place this responsibility on the pilots^{2/} and the concept is commonly referred to as the "see and be seen" principle. Rules for avoidance and right-of-way are set out in the Regulations also.^{6/} With respect to an IFR flight operating in VFR weather conditions the Flight Information Manual states, "During the time an IFR flight is operating in VFR weather conditions, it is the direct responsibility of the pilot to avoid other aircraft, since VFR flights may be operating in the same area without knowledge of ATC." In consonance with these provisions the vast percentage of flying today is separated by the "see and be seen" philosophy with little or no external traffic control assistance.

^{3/} Civil Air Regulations. Part 60.32 (b) 1, 2, 3, and 4.

^{4/} Civil Air Regulations. Part 60.30 (b) (1).

^{5/} See CAR Part 60.12 (c)

^{6/} See CAR Part 60.14 (a) through (c) and CAR Part 60.15.

At 0958 United Flight 718 reported its position to the CAA communications station located at Needles. This report indicated that the flight was over Needles at that time, its altitude was 21,000 feet, and it anticipated reaching the Painted Desert line of position at 1031 (revising the previous estimate of 1034). The flight indicated it would thereafter report over Durango. The Needles communicator forwarded this report, according to routine procedure, to the Albuquerque center at 1001 and to the Salt Lake center about 1013. The communicator stated that forwarding the report to Salt Lake was delayed by an interphone tieup. The controller at Salt Lake receiving the report was the one who previously was involved in the decision which denied TWA 2 the request for 21,000 feet as a cruising altitude when the flight was approaching Daggett at approximately 0921.

At 0959 Trans World Flight 2 reported its position to company radio located at Las Vegas. The flight reported it had passed over Lake Mohave at 0955, was 1,000 on top at 21,000 feet, and estimated reaching the 321-degree radial of the Winslow omni range station (the Painted Desert line of position) at 1031, with Farmington the next reporting position. In response to this the ground communicator repeated back the information, added the barometric pressure for Las Vegas, and told the flight that this pressure was falling rapidly. At 1001 the Las Vegas TWA communicator promptly forwarded this position report over long-line interphone to the Salt Lake center. This report was received by the CAA sector controller at 1001. The same controller received the position report of United 718 at 1013 from the CAA Needles communicator.

During the public hearing the Salt Lake controller and the CAA Director of Air Traffic Control were questioned as to whether or not traffic advisory information should have been issued the flights when the controller had received position reports from both flights and knew both were flying at the same altitude, estimating the Painted Desert line of position at the same time on converging courses. The controller stated that when the reports were received by him he had no knowledge of the track that either flight would make to the line of position because both were in the uncontrolled area and a specific track was not required. He said the Painted Desert line of position is nearly 175 miles long with no definite position within this distance. The estimates from the flights, therefore, did not mean they would converge there but merely that both would pass the line eastbound at that time. He testified that he was not required to give advisory information to flights which were in uncontrolled airspace and it was only a discretionary duty in the controlled area. He also said this advisory service would not be possible as a day-to-day practice without control of flights and more definite position information, as well as additional facilities and personnel.

The CAA Director of Air Traffic Control testified concerning the situation, stating that it was not the policy or concept of Air Traffic Control to provide traffic information outside of controlled airspace. He said normally such information would be of little value. Many aircraft unknown to Air Traffic Control may be operating in this area; further, Air Traffic Control has no authority over those aircraft that are known. The witness testified that with

respect to these two particular flights, the controller certainly knew about them; however, he explained that advisory information must be viewed in its overall application in day-to-day operations. He stated that advisory service for traffic in uncontrolled areas would be tantamount to positive control of all traffic which would require personnel, facilities, and equipment not presently available. He added that this was known to be correct, having several years ago attempted to provide this service on a test and evaluation basis. He added that the workload of an advisory service was found to be nearly equal to that required for a control service. He concluded that the present complement of persons assigned to perform the controller's functions in the uncontrolled areas could not be considered sufficient to offer either an advisory service or perform a control service.

Investigation relating to the progress of the flights shows they were according to the established performance of the aircraft. Both flights made good their estimates between position reports until the segments immediately prior to the Painted Desert line of position; for United from Needles and for TWA from Lake Mohave.

According to the United estimate the flight would reach the Painted Desert at 1031, or 33 minutes after passing Needles. Investigation showed the accident occurred at 1031, approximately 17 miles or nearly 3-1/2 minutes' flying time from the position of expected progress. Compared to another United flight, 708, a DC-7, which climbed over the same course to cruise at 21,000 feet approximately one hour earlier, Flight 718 should have reached the Painted Desert in its estimated elapsed time. Cruise performance of the aircraft also showed the estimate could have been made.

TWA Flight 2 also was making good its estimates as it climbed toward Lake Mohave. The estimates were in accord with accepted performance of the Constellation and the flight estimated it would reach the Painted Desert at 1031, or 36 minutes after passing Lake Mohave. This flight also was approximately 3-1/2 minutes' flying time from its estimated position when the collision occurred.

Winds aloft were carefully reviewed to determine whether or not they could have been a factor in the delays. It was learned that these winds were light in consideration of altitude and varied little from the winds forecast.

Determination of the time of the accident was an important phase of the Board's investigation. The severe damage sustained by the United Aircraft leaves little question but that the aircraft crashed soon after the collision and therefore the last transmission from its crew came very close to the collision time. Knowing the recording that contained the transmission also contained time checks and operated relative to actual time, it was learned that the message began at 1030:53. Pilots who knew the United crew and heard the final message or its transcription felt with reliable assurance that the voice was that of First Officer Harms.

The recorded transmission itself was also examined under laboratory conditions to determine what the exact message was, whether or not anything was said which was inaudible under normal listening conditions, and whether or not the tragedy was reflected during all or just part of the message. The latter objective would assist in determining whether or not the DC-7 crew sighted the L-1049 during the transmission and if the accident occurred during it. The analysis was based on a correlation of the spoken words with a spectrographic analysis, a technique used in "Visible Speech." Tests involving binaural listening and speech stretching were also made.

The laboratory results showed the principal speaker said, "Salt Lake, area (or ah), seven eighteen . . . we are going in." ^{7/} During the time represented by the dots a second speaker yelled two known words which were, "up . . . up." This speaker also yelled words which preceded "up." These were indefinite but fitted energy patterns of "look," "pull," or "come." The tests showed clearly that the principal speaker throughout was speaking between 100 and 200 cycles above the normal male voice pitch spectrograms. The background or second speaker's pitch was even higher, being well above that of a female voice; however, it was fairly certain that it was a male speaker. According to the laboratory study both general voice patterns, particularly as to pitch, showed the speakers were under great emotional stress, indicating that they were already in serious trouble.

An exhaustive search for eyewitnesses to the inflight collision was conducted. Many persons were contacted in the popular tourist area, as were employees of the Grand Canyon Park Service and residents of the surrounding areas. During this search no witnesses were found who saw the collision although at least one person apparently saw smoke from the crashes and dismissed it as a brush fire in the Canyon. Later, on July 10, two witnesses were made known to the Board and were called to appear at the public hearing. These witnesses stated that while driving west on Route 66 between Winona and Flagstaff they saw two aircraft collide. Their descriptions fitted the subject aircraft and especially the Constellation. Both witnesses stated that when collision occurred there was no evidence such as fire, smoke, or falling pieces and that following impact the aircraft seemed to continue on without falling but locked together.

Under intensive questioning, one of these witnesses testified that at the time she saw these two planes she saw them come together. Asked if she saw them collide she said she didn't realize at the time that they had. Questioned further as to how close they came together, she replied, "Too close." She was asked if she observed any space separating the two aircraft and she answered, "Just between the two tails." The witness was asked had she seen the two planes collide would she have said something about it to her husband. She replied that she would have but that she and her husband didn't discuss it. She further stated that she didn't recall her husband saying anything to her about the collision. The witness, a registered nurse, was asked if there had been any thought in her mind that this was a collision wouldn't she have gone to the nearest telephone and made some call to some official body of some authority. She said that she would have.

^{7/} Differences between initial listening and laboratory results relative to message context are recognized. See page 3.

Investigation showed that the collision occurred a short distance west of and above the wreckage locations, approximately 70 miles from the witnesses. Calculations and visual capability indicated that at this distance it would be impossible to see distinguishing physical features of the aircraft and nearly impossible to see the aircraft. Relative positions with respect to each other if visible, would be extremely deceptive. The Board does not question the sincerity of these witnesses but believes they must have seen two other aircraft; several are known to have been operating in this general area. At a considerable distance and at certain angles of observation two widely separated aircraft could well present the illusion of a collision.

A third witness reported having seen a puff of smoke in the sky over the Grand Canyon area. This witness was near Winslow, about 80 miles from the accident site, and was also proceeding in a private automobile west on Route 66. The puff of smoke seemed very high and from it two objects appeared to fall on a trajectory path and disappeared into lower clouds. This observation may have been the collision but because little detail could be seen it adds little to the investigatory objectives other than those already clearly established by more positive evidence.

To establish conclusively the importance of the information offered by these witnesses, Board investigators were stationed about 14 miles east of Flagstaff, the approximate position of the nearest witnesses as indicated by their testimony. On separate days United and Trans World flights flew the proposed routes of Flights 2 and 718, making position reports to the investigators according to a prearranged detailed plan. These were received by a CAA communications truck located with the investigators. Weather conditions on one day were better than those on the day of the accident and on the second day they were equal to or better than the accident day. Results of this work showed that the aircraft could not be seen though their exact positions were known, as were the angles on which to sight to the positions. Many reports and sightings were undertaken. Once a reflective flash was seen and binoculars were trained on it. With this assistance to the observers' normal vision the aircraft could be seen but it could not be identified as to type or make.

The Board was about to publish its report on this accident when, on February 1, 1957, it was advised of another alleged eyewitness to the collision. Shortly thereafter the witness was examined, at length, as to his observations in a deposition taken by the Board.

In substance, the witness testified that on June 30, 1956, while proceeding to Grand Canyon, he made his observations through the windshield of a Ford pickup truck in which he was traveling alone on Route 64 toward Desert View at a speed of 75-80 miles an hour up a prolonged incline in the road. At the point of observation he was between 5 and 7 miles south of Desert View or 15-17 miles south of the estimated collision point.

When questioned as to why he did not make public the fact that he had observed the accident, he answered that he did not want to embarrass himself.

Although he had several conversations with persons involved in the investigation of this accident, including Board personnel and personnel of the air carriers involved, he did not reveal the fact that he had seen the accident until seven months later.

The Board has carefully evaluated all of the testimony of this witness and concludes that it has no probative value. First, we cannot accept the witness' statement with regard to weather conditions. The record contains full and complete weather information as determined from weather reports, pilot reports, and an analysis of the synoptic situation. This testimony of the witness is in direct conflict with the known weather conditions, as clearly set forth by reliable and probative evidence contained in the record of this case.

Second, with respect to the witness' description of the relative positions and identification of the aircraft, it is unlikely that the witness could have seen these aircraft in the manner and from the place he described. This conclusion is based upon certain tests which were made by the Board immediately after the witness' deposition was taken, and the fact that the witness' observations were made while driving a truck at very high speed.

Under the circumstances, we cannot accept the witness' testimony.

The possibility that both aircraft could have been south of their courses, using the 3-1/2 minutes of unaccounted for time in this manner, is remote. A radius of action computation shows the time to be insufficient to bring the aircraft, especially TWA Flight 2, to a position much closer than 45 miles to the observers' point and thereafter flown to the known collision position.

The synoptic weather situation consisted of a thermal low centered a short distance northwest of Las Vegas, Nevada. A second low pressure area was centered in Nebraska from which a cold front extended southwestward into northern Colorado, thence westward through central Utah and Nevada as a quasi-stationary front during the day and night of June 29. Aloft the pressure distribution resulted in a southeasterly flow of moist air into northern Arizona. Numerous thunderstorms resulted during the afternoon and night of June 29 which increased the surface moisture. These factors prevailed during June 30 causing considerable low and high cloudiness and showers in the Grand Canyon area but the winds aloft had become more westerly, ranging from south-southwest at 8,000 to west at 21,000 feet. West of this area the routes were clear except for a local coastal stratus condition in the Los Angeles area and some scattered clouds en route but well below flight altitude.

The conditions described were indicated in forecasts made by the United States Weather Bureau and both company weather departments. These predicted there would be high broken clouds with light rain showers in the Colorado River area, the clouds becoming scattered at 8,000 feet by 1100. Scattered thunderstorms were expected south and east of a line defined from Denver through Milford, Prescott, and Phoenix. These were expected to dissipate in the Arizona and southeastern Utah sector after 0700 but to develop again by 1100. The freezing level was anticipated at 15,000 feet with light icing and

turbulence in the clouds. Moderate to severe turbulence was forecast in the thunderstorms. These buildups were expected to develop to 30,000 feet or higher, protruding through and above the lower coverage. Top of the lower clouds was anticipated at about 15,000 feet with good visibility above and outside the thunderstorms. The position of the sun was nearly overhead at 1031 (1131 m. s. t.).

Pilots who flew near the accident area furnished some on-the-spot weather information which essentially supported the forecast conditions. One airline captain passed about 25 miles southwest of the accident site a few minutes after the accident occurred. He stated that a lower cloud coverage commenced well east of Las Vegas with increasing coverage from Havasu Creek eastward, becoming nearly overcast 20-25 miles west of Grand Canyon Village. Cruising at 19,000 feet he noted several towering cumulus clouds, one of which was located over the immediate Grand Canyon Village area and others farther east and northeast. He saw no buildups west of Grand Canyon Village. He estimated the height of these to equal or exceed 25,000 feet and stated that they appeared to still be in the active or building stage. He was unable to estimate the size of the thunderstorms relative to diameter, length, or width. Below, he said, the top of the overcast was approximately 15,000 with few breaks but recalled one such break through which he saw Grand Canyon Airport, located 25 miles southwest of the accident site. The captain stated that he operated clear of clouds with no difficulty as he passed west and southwest of the accident site.

Other pilots flying below the overcast over the Grand Canyon saw a shaded rain area to the west. One pilot said there were breaks in the overcast with excellent visibility below it. He added that the condition described existed in all directions to the limit of his visual ability. Through the breaks he noted no evidence of any appreciable buildups.

Analysis

The several areas of damage previously described formed the foundation for a successful although arduous analytical study relative to the inflight collision sequence, the extent and effect of the collision damage, and the relative attitudes of the aircraft at the instant of impact.

The initial impact occurred with the DC-7 moving from right to left relative to the L-1049 and with the L-1049 moving to the right and aft relative to the DC-7. From analysis of physical damage in consideration of locations of the damaged components of the aircraft, it appears that first contact involved the center fin leading edge of the L-1049 and the left aileron tip of the DC-7. Instantly thereafter the lower surface of the DC-7 left wing struck the upper aft fuselage of the Constellation with disintegrating force. Without question this force caused complete destruction of the aft fuselage and destroyed the structural integrity of the left wing outer panel. As this occurred and the aircraft continued to pass laterally, the left fin leading edge of the Constellation and the left wing tip of the DC-7 made contact, tearing off pieces of both components. During this same time the DC-7 No. 1 propeller

inflicted a series of cuts in the area of the aft baggage compartment of the L-1049. This entire sequence occurred in less than one-half second and in such a manner that an interlocking of the aircraft was virtually impossible.

From the extent of damage and the locations of various components on the ground, the collision ripped open the fuselage of the Constellation from just forward of its tail to near the main cabin door. The collision also caused the empennage of the Constellation to separate almost immediately. This aircraft then pitched down and fell on a short forward trajectory to the ground. Consideration of these factors leads the Board to conclude that the collision occurred in space over a position just west of the TWA crash site.

The United aircraft appears to have sustained lesser but equally critical damage affecting flight. Most of its left outer wing separated during the collision and it appears likely that the horizontal stabilizer of the DC-7 was struck by pieces torn off the Constellation. It is also reasonable that damage to the left wing restricted aileron control. It is believed that the DC-7 fell less steeply, probably on a turning path, to the ground.

For damage to have resulted as described earlier and for other areas to have escaped inflight contact, the aircraft had to be oriented in a certain manner relative to each other when the collision occurred. Additionally, and independent of the matching of damage, a study was also made relative to the propeller cuts. Both studies gave nearly identical results relative to the angle between the aircraft at the instant of impact. This angle was found to be approximately 25 degrees relative to the longitudinal axes.

From the layout work matching the inflight contact areas, it was determined that the DC-7 left wing was above the L-1049 relative wing plane or the DC-7 was rolled approximately 20 degrees right wing down relative to the L-1049. The study also indicated the aircraft were oriented such that the vertical distance between empennages of the aircraft was less than the vertical distance between their nose sections. The difference as an angle was between 5 and 10 degrees. It is important to recognize that the aircraft attitudes described are relative or with respect to each other and do not necessarily reflect their orientation with respect to the ground.

Because some components of the aircraft were not recovered and others were destroyed, it was not possible to determine completely whether or not any malfunction occurred to either aircraft before impact. From all that could be examined there was no evidence of malfunction and from all the evidence surrounding the accident the Board believes there was none.

Analysis of all the available weather information (see attachment 2 as reference), including pilot reports, indicates that the forecast conditions for the flights were reasonably accurate. It shows that the two flights departed Los Angeles and climbed through an overcast approximately 700 feet thick to clear conditions on top. The overcast was local in nature and confined to the Los Angeles coastal area. Thereafter, the flights, except for some scattered clouds, were in clear weather as they climbed eastbound over their respective tracks.

Clear weather appears to have prevailed east of Las Vegas along the Colorado River to near Havasu Creek but becoming overcast with a few breaks beginning a short distance east of Havasu Creek. Along the proposed routes of TWA 2 and UAL 718, scattered clouds commenced shortly east of the California-Arizona border. Eastward therefrom clouds increased to broken, then overcast with some breaks in the Grand Canyon area to somewhat east of the accident site. Tops of this main weather coverage were approximately 15,000 feet with several lower layers, the lowest being about 2,000 feet above the ground.

Northwest of Grand Canyon Village, or over the western portion of the main Grand Canyon, the first of several scattered buildups appears to have existed. It appears to have been isolated with others northeast of it. The build-ups were apparently formed in the lower clouds and protruded through and above them to approximately 25,000 feet. An airline captain described the westernmost buildup as large but of an indeterminable width and length. He believed it was almost over Grand Canyon Village. Pilots below the overcast saw no evidence of it there but at least two noted a rain area northwest of this position. It is entirely likely that the rain area was from the buildup noted by the captain from above. Pilots flying below the overcast also stated that they saw breaks in the overcast but that they were few and scattered. They observed that the overcast condition covered most if not all of the Grand Canyon.

From the evidence available the Board is of the opinion that the weather conditions at 21,000 feet would not have precluded flight in VFR conditions in this accident area but that deviations may have been required to circumvent the buildups while the subject flights traversed the area.

According to company procedures United flights were not permitted to fly in instrument weather conditions while operating off airways. Similarly, TWA procedures precluded instrument flight under the flight clearance on which its Flight 2 was proceeding at the time of the accident. Each company, under the conditions during which this accident occurred, therefore required its flight to adhere to visual flight rules. Further, it is unlikely that Captain Gandy would proceed into instrument weather conditions, having previously been informed that the United flight was in the general area at 21,000 feet. The Board is therefore of the firm opinion, based on the weather conditions, company procedures, and good pilot practice, that both flights were operating according to rules prescribed for VFR conditions when the collision occurred.

The last position report from each flight indicated, at the time the report was given, that each was at 21,000 feet. Although there was no requirement for either to remain at that altitude in the uncontrolled area, with respect to Air Traffic Control, each company did require that it be notified of an altitude change. Because there was no notice and no known reason for the flights to alter altitude, it is considered reasonable to believe that the collision occurred at 21,000 feet.

Considering each flight's estimate to the Painted Desert, together with aircraft performance, it appears that both flights should have reached the

line of position about 17 miles, or 3-1/2 minutes' flying time, farther east when the accident occurred. Although there are several possibilities, no definite conclusion has been reached as to the cause of the 3-1/2-minute delay of these aircraft. One possibility is that it could have been caused by maneuvering to provide a more scenic view for the passengers, although the evidence is not sufficient to establish this fact. Another possibility is that a less favorable wind was encountered during the subject segments than was used for estimates which slowed the progress of the flights. A third possibility is that one or more buildups in the Grand Canyon area may have required deviations and, if so, could account for the time element involved.

At approximately 1013 the Salt Lake controller was in possession of the last position report made by each of the subject flights. He was then aware that when the reports were made both aircraft were operating at 21,000 feet, were on converging courses, and were estimating the Painted Desert at the same time. He advised neither flight of this situation. In considering whether or not this should have been done, the traffic control concept, the controller's express duties, and the requirements involved to provide this information to flights must be considered.

Air Traffic Control undertakes to separate air traffic when it is operating in accordance with an IFR clearance and while it is within the confines of controlled airspace. If instrument weather conditions exist and the above requirements are met, all air traffic would be separated. However, when visual flight conditions exist instrument traffic is separated only from other like traffic and not from aircraft being flown under visual flight rules, much of the latter being unknown to Air Traffic Control. For this reason flights in visual conditions are required to provide their own separation regardless of flight plan or clearance.

Outside the controlled airspace the air traffic control concept has not embraced the responsibility for separation of air traffic regardless of flight plan, clearance, or weather conditions. In this area no control is exercised by Air Traffic Control, its principal function being to monitor the progress of flights through an uncontrolled area so that an orderly flow of instrument traffic may be accomplished into the adjacent control area. Control is not presently available in the uncontrolled airspace because sufficient facilities and means for such control do not exist.

At the present time traffic advisory information to flights is offered when and where control of air traffic is being exercised. Then, such advisory is discretionary with the controller and is not a mandatory procedure of control. Accurate and worthwhile traffic information requires that the controller be informed of the aircraft involved and have precise and timely information on the position of flights relative to their altitude and lateral and forward position along a defined track. This information must thereafter be posted and correlated with like information on other flights to determine whether or not a conflicting situation exists. In the uncontrolled airspace, as previously stated, flights are permitted greater flexibility to take advantage of wind and weather factors. Further, in this area the navigational aids

enabling a flight to report its position with the precision necessary to enable accurate advisory information are insufficient. The aforementioned factors affecting the value of traffic advisory information are evident with respect to TWA 2 and United 718. Both flights were somewhat north of their proposed tracks, both were approximately 17 miles west of where they had estimated they would be at that time, and their actual tracks intersected a considerable distance before the proposed tracks converged. Such deviations are not unusual in off-airways operation.

Although knowledge of the projected flight paths of the subject flights could have prompted the Salt Lake controller to offer both flights traffic advisory information on a voluntary basis, giving the best information available to him at the time, the Board is of the opinion that the existing control concept, Air Traffic Control policies and procedures, and the express duties of a controller did not require him to do so.

This accident, as nearly all other midair collisions, apparently occurred in visual flight weather conditions and there is no reason to believe the aircraft were not being operated in accordance with cloud separation criteria of visual flight rules. Under these conditions and according to these rules the vast portion of flying today is being conducted. Accordingly, the present means for avoiding collision rests with the pilot to see and avoid other aircraft.

Extensive study of most collision accidents has shown that there was an opportunity, of varying degree, for the pilot or pilots to see the conflicting aircraft in sufficient time for them to take evasive maneuvers to avoid the accident. In many of these accidents where there was survival, however, testimony of the pilots was that they were maintaining a careful lookout but despite it they did not see the other aircraft in time to avoid it or that they did not see it at all.

Collision studies, including controlled flight tests, have pointed out that seeing other aircraft in flight is difficult. The degree of such difficulty is variable with numerous tangible and intangible factors affecting it. The first tangible factor is the angular limits of cockpit vision, or the vision afforded by cockpit structure and design only.

The second tangible factor is visual range or the distance that an object can be seen. Many conditions and circumstances enter into this factor and are variable. Some of these are color of the object, its background, and the contrast between them. Others are mass of the object, its angular size and shape, and the atmospheric condition of visibility. The latter may also include altitude effect and cloud obstruction.

A third group of factors is physiological or human and many of these are intangible, depending on the individual's physical condition, degree of fatigue, and training. The human eye will best see an object when it is within the sensitive or focal field of vision, which is two to three degrees. An object may be seen through the peripheral portion of vision or the area of several degrees outside of the focal field. The number of degrees is dependent upon motion

and/or the aforementioned factors providing sufficient stimuli. It may be noted that aircraft converging on constant, unvarying collision courses provide no relative motion when viewed from the aircraft. Searching for aircraft within the visual limits of cockpit visibility requires scanning through those limits. This requires time, the amount being allied to the physiological factors and the adequacy depending on all considerations, including closure speed.

Allied to the element of opportunity it is important to recognize that the operation of a modern aircraft requires regular and frequent attention of the pilot or pilots to duties within the cockpit. Attention to instrumentation, both operational and navigational, is required during all phases of flight, as well as computations and records pertaining to the progress and anticipated progress of the flight.

Many combinations of adverse factors, conditions, and circumstances can result in a limited opportunity to see another aircraft. On the other hand the opportunity to see another aircraft may be good. Here the factors act to a good and reasonable opportunity for the vigilant pilot and in this regard the Board expects pilots to maintain the highest degree of vigilance.

It is recognized that the basic means for traffic separation in VFR conditions is presently the "see and be seen" philosophy. This concept has existed as a matter of necessity, with its known limitations, and will continue until there are sufficient technological advances to provide additional assistance to the pilot for collision avoidance. The progress of aviation is moving rapidly toward higher altitudes and greater speeds, with traffic in increasing density. Fully aware of this and its effect, the Board is lending its support to industry, other governmental agencies, and interested persons to find and develop methods, means, and devices which will assist the concept of visual separation.

Knowing full well that insufficient evidence would preclude determining with positive results the existing opportunities for the subject crews to see the conflicting aircraft, the Board nevertheless conducted an exhaustive analysis. This was done to present all information possible from the available evidence. The analysis was successful in this objective and disclosed much which the Board believes will assist its principal goal of greater safety in aviation.

Since the attitudes of the aircraft relative to the ground and their probable flight paths prior to collision are so closely interrelated, they can be treated together. A determination of these is imperative relative to the opportunity for the pilots to have seen the conflicting aircraft.

As indicated, correlation of the physical damage relates one aircraft with respect to the other and not with respect to the ground. Obviously, the physical orientation is valid only at the instant of impact. Because of this, and in the absence of eyewitnesses, it is not known whether one or both aircraft were rolled, pitched, or yawed relative to the ground. Without a known orientation of at least one of the aircraft with respect

to the ground, an analysis cannot determine a single flight path of the aircraft prior to the collision, nor is it possible to establish the flight paths by other known factors in this accident. It is therefore necessary to evaluate the objective on the basis of several flight path combinations, knowing that only one existed. Generally, however, the possibilities may be narrowed into two broad categories with variations. The possibilities may also be limited by the known orientation of the aircraft to each other at the instant of impact, which precludes certain other relative attitudes between the aircraft.

The first category assumes that there was no evasive action prior to collision and that one or both aircraft were turning within the limits afforded by the known collision orientation. This category accepts as reasonable that both aircraft were being flown commensurate with their performance for the en route phase of flight. Analytical studies recognized the variations to this category but found that three limit considerations seem to cover the infinite number with respect to the pilots' visual opportunities. Two of these are that either aircraft was turning while the other flew straight and level to collision; the third is that both were turning prior to the accident.

The second category of possibility is based on the assumption that there was an evasive action initiated by one or both flights but that it came too late to avoid the accident. Again, it is reasonable to believe the evasive action was limited to the known orientation and that the aircraft were being flown according to the normal performance for the en route phase of flight. The evasive action was also limited to aileron-elevator type maneuvers. Although rudder displacement was studied and evaluated, the aileron-elevator action appeared to be more consistent with the preponderance of all evidence; however, this was not entirely conclusive. Even accepting this limit there are variations, but these can be narrowed by a limit consideration. This is possible because maneuver characteristics of both aircraft showed that an evasive action without sufficient time to avoid the collision would not appreciably alter the flight path of either aircraft from flight paths which presumed there was no evasive action. It must be noted, however, that relative attitudes of the aircraft would be changed. Accordingly, the studies under the second category relating to the visual opportunities of the crews are not appreciably altered from the situation where both aircraft were approaching one another in straight and level flight at the angle between the longitudinal axes shown to have existed at the initial impact, 25 degrees.

It is known that several cloud buildups existed in the immediate area of the collision and their heights extended well above the cruising altitudes of both flights. Although it is unknown, it is entirely possible that the aircraft may have been flown so that one was on each side of a buildup shortly before collision. The effect of this would, of course, preclude the crews from seeing the other aircraft during the time the cloud or clouds were between them. Clouds would also require course deviation in certain situations. They would also seriously limit the time for pilots to see the conflicting aircraft, the amount depending on the size and shape of the clouds, the lateral distance maintained by the flights from them, and the distance of the clouds from the

collision point. Thus, a cloud positioned close to the collision point would limit the time opportunity as would one which was narrow or elongated. The intervening cloud factor appears to be a possibility and therefore was a necessary consideration in the visual opportunity study. To this end several representative cloud sizes and shapes were selected and introduced in the analytical study. The study also included the consideration which presumed that clouds would not have been a factor. The study accepted as the limit of visual range a distance of five to six statute miles and assumed that the aircraft passed the cloud formation at a horizontal distance of 2,000 feet and that they were at the same altitude.

The results of this analysis were then applied to the individual crew members from their respective cockpit positions. This was accomplished in the form of windshield displays, thereby incorporating the several situations with the angular limits of cockpit vision. Attachment 3 reflects the results as applied in this manner.

From the display it is apparent that the L-1049 was within the angular limits of the DC-7 window area from the captain's seat during all the flight path situations. In the situation of no intervening clouds, motion would be involved in three of the four situations. Windshield formers would block the captain's view for varying portions of the time opportunity. The time opportunity with no clouds was 50 to 120 seconds according to the situation being considered. The worst cloud situation could reduce the time opportunity to as low as 12 seconds.

With respect to the DC-7 first officer's position, the L-1049 was within the angular limits of the DC-7 window area during two of the limit considerations and during the early part of the other two. In the "no cloud" factor situations the L-1049 would have been near maximum visual range in two conditions, without relative motion in one, and with relative motion in another. Time opportunity without intervening clouds and with both aircraft straight and level was 120 seconds. For the other three considerations, including the intervening cloud condition, the opportunity varied from 12 seconds to 50 seconds.

In only one of the conditions does it appear that the L-1049 captain could have seen the DC-7 from his seat; in this the time opportunity was for a period of up to 40 seconds with no intervening clouds. In the other three conditions, according to the study, his opportunity was precluded by the limits of cockpit structure or because the DC-7 was beyond visual range.

The study indicates that without the intervening cloud condition the DC-7 was within visual range and within the angular limits of cockpit vision from the L-1049 copilot's seat during three of the four flight path situations. Then the time opportunity varied from 50 to 120 seconds, according to the situation. Two of the displays reveal relative motion. Again, in the worst cloud situation his time opportunity was as low as 12 seconds.

Analysis of the various possible flight path variations relative to cockpit angular limits of vision has shown that one or both pilots of one

aircraft could have been precluded from seeing the conflicting aircraft during critical periods. The study must also recognize the possible effect if one crew member was occupied with cockpit duties and he alone had the visual opportunity during this time.

The Board has shown the existence of cumulus-type clouds in the accident area. It has shown that these clouds may not have been an intervening factor between the flight paths of the aircraft. Here the time opportunities for the pilots to effect visual separation were good. In this situation, despite the possible flight path variations, and in consideration of the aforementioned factors controlling visual ability of the pilots, the Board is of the opinion that the range of opportunities was adequate. If this situation existed, the Board believes the pilots should have seen and avoided the other's aircraft.

On the other hand, evidence has shown that during other of the possibilities the pilots' opportunity to effect visual separation could have been seriously impaired. Analysis has shown how clouds, if positioned between the flights at a critical time, could have reduced the time opportunity for collision avoidance to less than the minimum of 15 or more seconds necessary for scanning, pilot reaction, and airplane response.

The Board has carefully studied and arduously evaluated all the available evidence surrounding this accident. It has learned all that existing methods of investigation and evaluation enabled it to do. This was done without the assistance of survivors or eyewitnesses whose testimony is considered imperative to a complete knowledge and to single conclusions in the collision-type accident. Because of the lack of this vital information and when all factors, including intervening clouds, cockpit visual limitations, cockpit duties, the several flight path variations, the time opportunities, and the physiological limits to human vision are considered, the Board concludes there is not enough evidence to determine whether or not there was sufficient opportunity for the pilots to avoid the collision.

Findings

On the basis of all available evidence the Board finds that:

1. The companies, the aircraft, and flight crews were properly certificated.
2. Preparation for both flights was complete and routine.
3. The flights were properly dispatched on IFR flight plans, over accepted high-altitude direct routes.
4. Approaching Daggett, TWA 2 requested its company radio to obtain 21,000 feet as an assigned altitude, or 1,000 on top.
5. Company radio requested 21,000 feet IFR from ARTC. This was denied by ARTC. Request was then made for 1,000 on top. This was approved and clearance issued. The flight climbed to and proceeded at 21,000 feet.

6. As an explanation for the denial of 21,000 feet, TWA 2 was furnished pertinent information on UAL 718.

7. The last position report by each flight indicated it was at that time at 21,000, estimating the Painted Desert line of position at 1031.

8. The Salt Lake controller possessed both position reports at approximately 1013, at which time both flights were in uncontrolled airspace.

9. Traffic control services are not provided in the uncontrolled airspace and according to existing Air Traffic Control policies and procedures the Salt Lake controller was not required to issue traffic information; none was issued voluntarily.

10. A general overcast with some breaks existed at 15,000 feet in the Grand Canyon area.

11. Several cumulus buildups extending above flight level existed; one was nearly over Grand Canyon Village and others were north and northeast in the area of the collision.

12. The collision occurred at approximately 1031 in visual flight rule weather conditions at about 21,000 feet.

13. The collision in space was above a position a short distance west of the TWA wreckage area, 17 miles west of or approximately 3-1/2 minutes' flying time from the Painted Desert line of position.

14. Under visual flight rule weather conditions it is the pilot's responsibility to maintain separation from other aircraft.

15. At impact the aircraft relative to each other converged at an angle of about 25 degrees with the DC-7 to the right of the L-1049. The DC-7 was rolled about 20 degrees right wing down and pitched about 10 degrees nose down relative to the L-1049.

16. There was no evidence found to indicate that malfunction or failure of the aircraft or their components was a factor in the accident.

Probable Cause

The Board determines that the probable cause of this mid-air collision was that the pilots did not see each other in time to avoid the collision. It is not possible to determine why the pilots did not see each other, but the evidence suggests that it resulted from any one or a combination of the following factors: Intervening clouds reducing time for visual separation, visual limitations due to cockpit visibility, and preoccupation with normal cockpit duties, preoccupation with matters unrelated to cockpit duties such as attempting to provide the passengers with a more scenic view of the Grand Canyon area, physiological limits to human vision reducing the time opportunity to see and avoid the other aircraft, or insufficiency of en route air

traffic advisory information due to inadequacy of facilities and lack of personnel in air traffic control.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

Member Louis J. Hector did not take part in the adoption of the report.

S U P P L E M E N T A L D A T A

Investigation and Hearing

The Civil Aeronautics Board was notified that the aircraft were overdue and were assumed to be down at 1500, June 30, 1956. Investigators were promptly dispatched to the carriers' search headquarters where notice was received that the wreckage was located in the Grand Canyon. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in the Department of Commerce Auditorium, Washington, D. C., on August 1, 2, 3, and 4, 1956.

Air Carriers

Trans World Airlines, Inc., a Delaware corporation, is a scheduled air carrier with its principal offices located at Kansas City, Missouri. It possesses a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These authorize the carrier to transport by air persons, property, and mail over various routes including that from Los Angeles, California, nonstop to Kansas City, Missouri.

United Air Lines, Inc., is a Delaware corporation with its corporate offices in Chicago, Illinois. The company is engaged in transporting by air persons, property, and mail. It holds a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These authorize operation over a number of routes including that from Los Angeles to Chicago.

Flight Personnel

1. Trans World Airlines

Captain Jack S. Gandy, age 41, was employed by the company December 26, 1939, and became captain in March 1942. He held a valid airman certificate with currently effective airline transport and Lockheed 1049 ratings. Captain Gandy had a total of 14,922 flying hours, of which 7,208 were in the Lockheed 1049. His rest period prior to Flight 2 of June 30, 1956, was 16 hours. Captain Gandy was qualified over the subject route and had flown it 177 times. His last proficiency check was January 10, 1956, and his last physical, first-class, was completed, without waivers, April 5, 1956.

Copilot James H. Ritner, age 31, was employed by the company on June 2, 1952. He held a valid airman certificate with multi-engine and instrument ratings. His total flying time was 6,976 hours, with 825 hours in the equipment involved. His last physical examination was dated August 23, 1955, and he received an 18-hour rest period during the 24 hours prior to Flight 2 of June 30, 1956.

Flight Engineer Forrest D. Breyfogle, age 37, was employed by Trans World Airlines October 1, 1945. He held a currently effective mechanic certificate with airframe and engine ratings, a flight engineer certificate, and a radiotelephone permit. Mr. Breyfogle had accumulated 7,896 flying hours, of which 7,237 were in the equipment involved. His last physical examination was received on May 25, 1956.

Flight Engineer Harry H. Allen was aboard Flight 2 as an additional crew member without flight crew duties.

Hostess Tracine E. Ambruster was employed by the company April 24, 1950.

Hostess Beth E. Davis was employed July 7, 1953.

2. United Air Lines

Captain Robert F. Shirley, age 48, was employed by United Air Lines July 22, 1937, and was promoted to captain November 1, 1940. During his employment he accumulated 16,492 flying hours, of which 1,238 were in the DC-7. He held a valid airman certificate with, among others, currently effective airline transport and DC-7 ratings. Captain Shirley completed his last first-class physical March 8, 1956. Prior to the subject flight he had a rest period of 63 hours. Captain Shirley was qualified over the route involved and had flown it on a regular basis since October 1, 1955.

First Officer Robert W. Harms, age 36, entered the employment of United Air Lines February 7, 1951. He held a valid airman certificate with airline transport and DC-7 ratings. First Officer Harms was captain-qualified on the DC-3. He had a total of 4,540 flying hours, with 230 in the equipment involved. He received a CAA physical examination on May 28, 1956, and prior to Flight 718 of June 30, 1956, had 155 hours of off-duty time.

Flight Engineer Gerard Fiore, age 39, was employed March 26, 1948, as a mechanic. He became a flight engineer February 22, 1951. He held a currently effective mechanic certificate with airframe and engine ratings, and a valid flight engineer certificate. Mr. Fiore had accumulated 2,670 flying hours since March 1, 1953, when records of the company became effective on engineer personnel. During this time he flew 285 hours in the equipment involved.

Stewardess Nancy L. Kennitz was employed by the company February 28, 1954.

Stewardess Margaret A. Shoudt was employed September 1, 1954.

The Aircraft

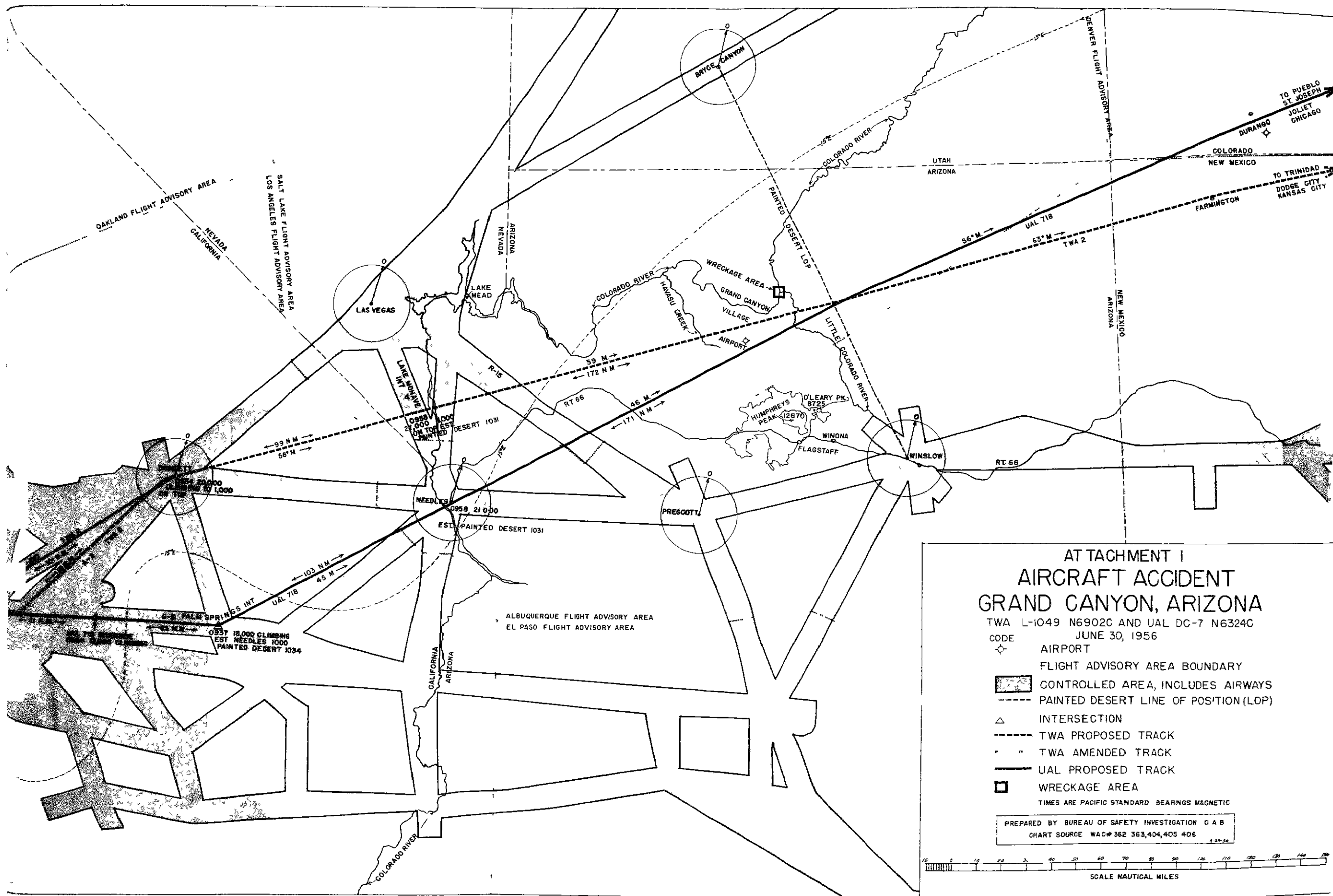
1. Trans World Airlines

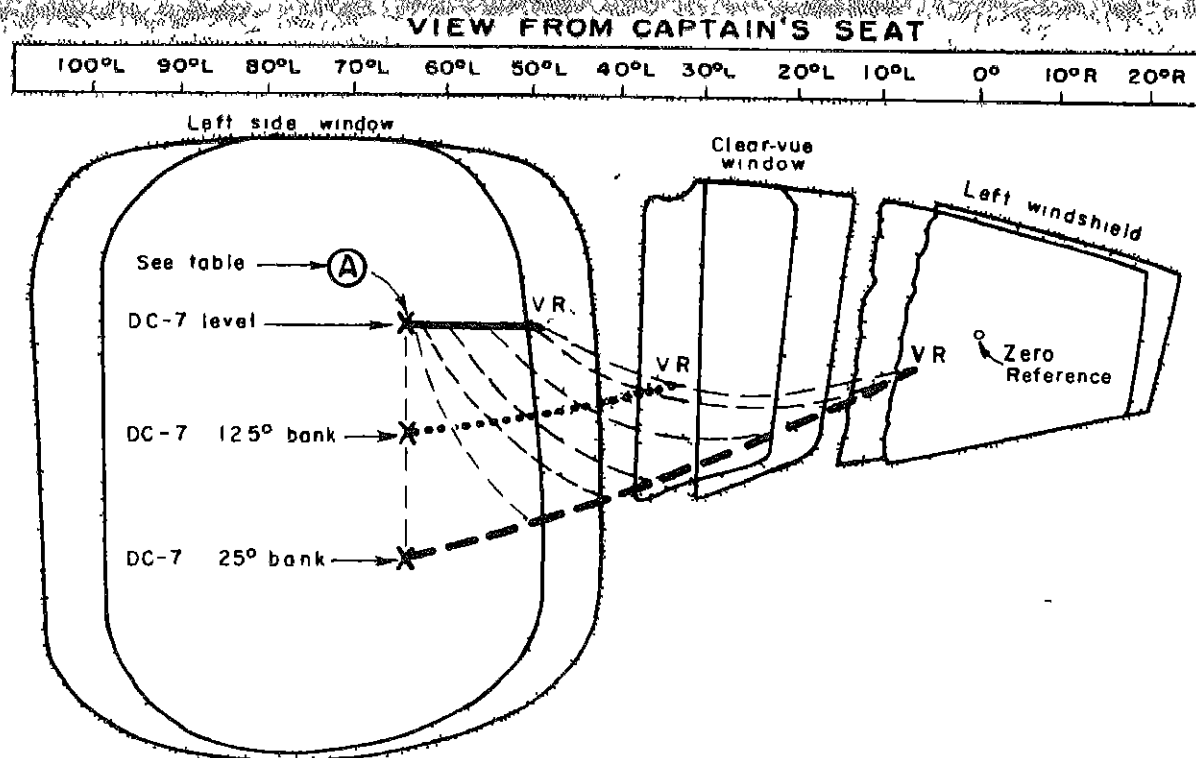
N 6902C, a Lockheed Constellation, model 1049A (covered in CAA aircraft specification No. 6A5 under the heading Model 1049-54), bore manufacturer

serial number 4016. The aircraft was placed in service by the company May 22, 1952, and had a total of 10,519 flying hours, of which 2,017 hours were accumulated since the last major overhaul, with a line maintenance check accomplished just prior to Flight 2 of June 30, 1956. The aircraft was equipped with Wright engines, model WAD975C18CB-1, and Hamilton Standard propellers, model 43E60 with model 6901A-0 blades.

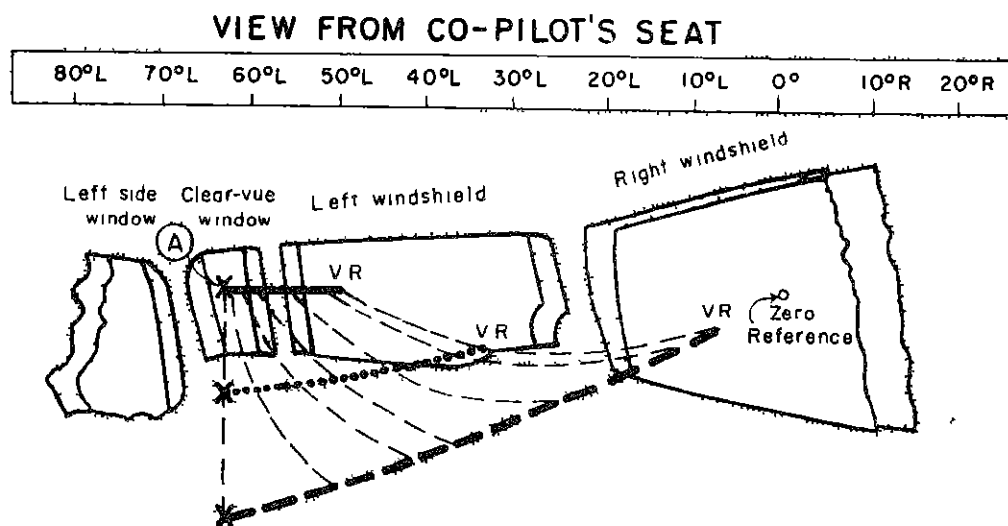
2. United Air Lines

N 6324C, a Douglas DC-7, was purchased by United Air Lines January 10, 1955. It bore manufacturer's serial number 44288 and company number 9124. The aircraft had been flown 5,115 hours, 1,125 of which were accumulated since its last overhaul. A line maintenance check was completed before origination of Flight 718 of June 30, 1956. The aircraft was equipped with Wright engines, model 972TC18DA-2-4. The propellers were Hamilton Standard 34E60 with model 6921C-8 blades.





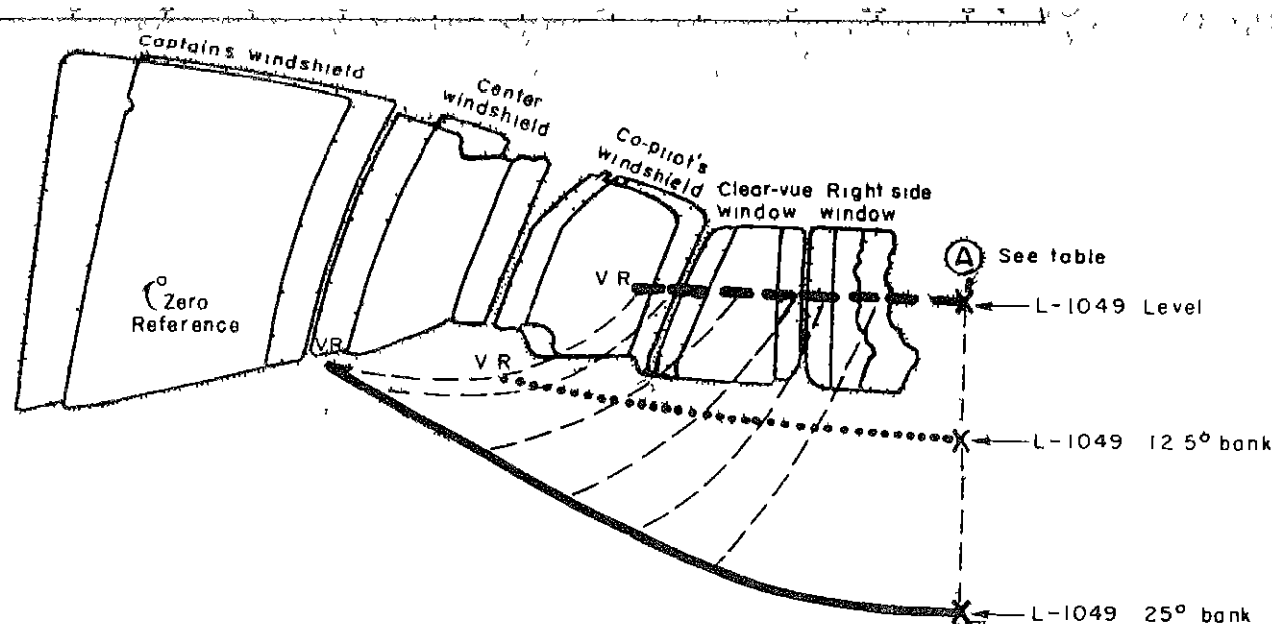
Cloud diameter — Miles	(A)	1	2	5	10	-
Approx time to collision — Seconds	12	21	27	38	50	60
Approx distance between aircraft — Miles	8	15	2	33	48	54



Cloud diameter — Miles	(A)	1	2	5	10	-
Approx time to collision — Seconds	12	21	27	38	50	60
Approx distance between aircraft — Miles	8	15	2	33	48	54

TABLE (A) This applies only when both the DC-7 and L-1049 fly straight and level and converge at approx 25° Position on window is constant at point (A) until instant before collision					
Cloud condition and limitation	No clouds and VR 5-6 miles	5 miles diameter	2 miles diameter	1 mile diameter	(A)
Approx time to collision — Seconds	120	109	57	27	17
Approx distance between aircraft — Miles	53	49	25	17	4000'

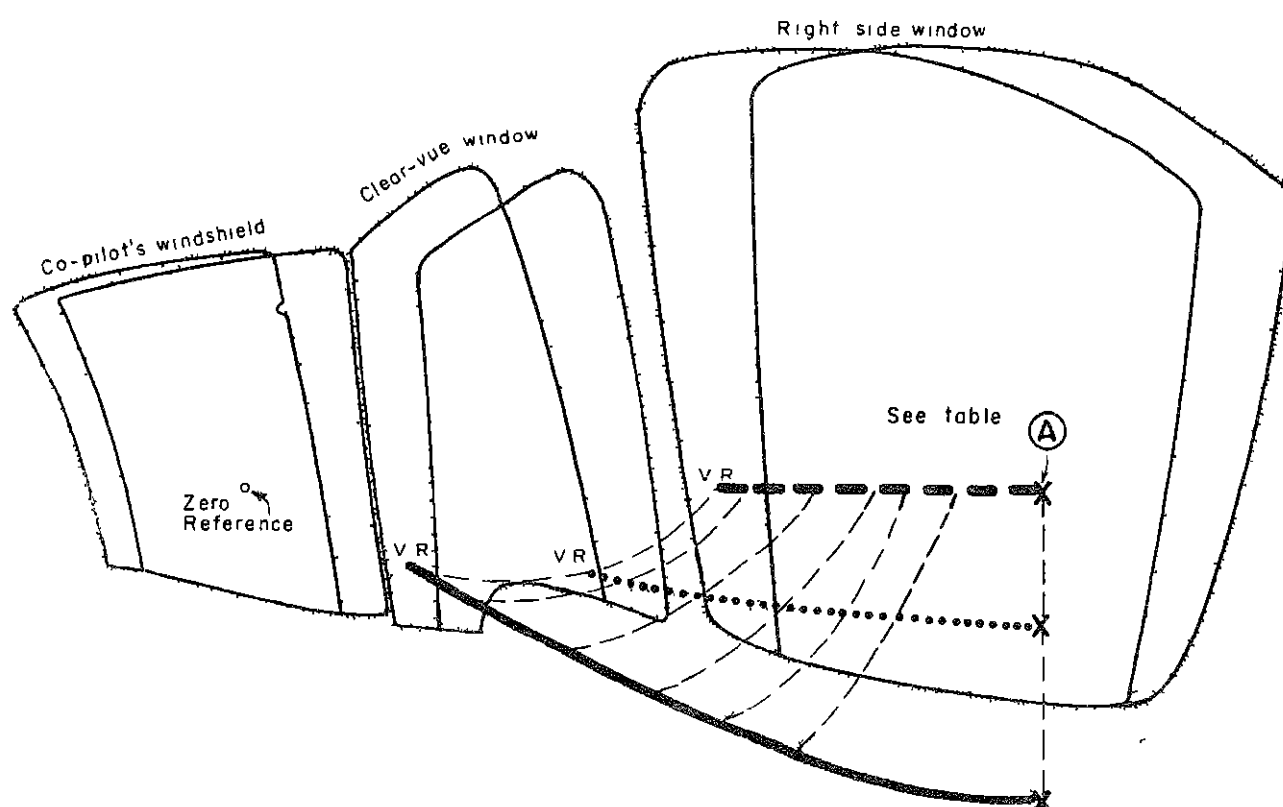
- DC-7 straight and level and L-1049 in left turn at 25° bank
- DC-7 in right turn at 125° bank and L-1049 in left turn at 125° bank
- DC-7 in right turn at 25° bank and L-1049 straight and level
- X L-1049 position instant before collision
- VR Point at which the L-1049 first appears assuming a visual range of 5 to 6 miles and with crew positions in cockpit assumed as average
- Monocular vision area — where crew members can see with only one eye
- Clear area within windshield or window outline — crew members can see with both eyes
- Opaque area — area around windshield and side windows with no outside vision
- — — — — Dash lines connect corresponding points on three paths shown
- (A) Elongated cloud or cloud shelf diminishing eastward to a point



Cloud diameter - Miles	-	10	5	2	1	△
Approx time to collision - Seconds	60	50	38	27	21	12
Approx distance between aircraft - Miles	54	48	33	2	15	8

VIEW FROM CO-PILOT'S SEAT

20°L	10°L	0°	10°R	20°R	30°R	40°R	50°R	60°R	70°R	80°R	90°R
------	------	----	------	------	------	------	------	------	------	------	------



Cloud diameter - Miles	-	10	5	2	1	△
Approx time to collision - Seconds	60	50	38	27	21	12
Approx distance between aircraft - Miles	54	48	33	2	15	8

TABLE (A) This applies only when both the DC-7 and L-1049 fly straight and level and converge at approx 25° Position on window is constant at point (A) until instant before collision					
Cloud condition and limitation	No clouds and V R 5-6 miles	5 miles diameter	2 miles diameter	1 mile diameter	△
Approx time to collision - Seconds	120	109	57	27	17
Approx distance between aircraft - Miles	53	49	25	17	4000'

— L-1049 straight and level and DC-7 in right turn at 25° bank

..... L-1049 in left turn at 12.5° bank and DC-7 in right turn at 12.5° bank

--- L-1049 in left turn at 25° bank and DC-7 straight and level

X This point indicates DC-7 position just before collision. Angle changes rapidly in last 1-2 seconds and moves to the right off cockpit window

VR Point at which the DC-7 first appears assuming a visual range of 5 to 6 miles and with crew positions in cockpit assumed as average

Monocular vision area—where crew members can see with only one eye

Clear area within windshield or window outline—crew members can see with both eyes

Opaque area—area around windshield and side windows with no outside vision

--- Dash lines connect corresponding points on three paths shown
△ Elongated cloud or cloud shelf diminishing eastward to a point

DC-7 PATHS ONL-1049 COCKPIT WINDOWS
TWA-UAL-COLLISION GRAND CANYON, ARIZONA, JUNE 30, 1956
ATTACHMENT 3, Page 2

American Aviation Heritage
National Historic Landmark Report



Name of Property:	1956 Grand Canyon TWA-United Airlines Mid-Air Collision Site
City, State:	Grand Canyon, Arizona
Significant Dates:	June 30-July 12, 1956
NHL Criteria:	1
NHL Theme:	V. Developing the American Economy 3. Transportation and Communication
Previous Recognition:	Grand Canyon National Park Archeological Site AZ:C:13:0755
National Historic Context:	2011 <i>American Aviation Heritage National Historic Landmarks Theme Study</i>

NHL Significance:

- The 1956 mid-air collision between commercial airliners TWA and United Airlines is associated with the modernization of America’s aviation airways. In the decade after World War II, congested airspace and inadequate aviation facilities caused an “airways crisis.” In this situation, civilian and military aircraft operated under separate air traffic control systems, and pilots in uncontrolled airspace flew under the “see and be seen” principle with little or no external traffic control assistance. Efforts to address the airway crisis under the Eisenhower administration had begun, but the air traffic control system was outdated and the specter of a mid-air collision loomed.
- On June 30, 1956, under the “see and be seen” principle, a Trans World Airlines Super Constellation L-1049 and a United Airlines DC-7 collided in uncongested airspace 21,000 feet over the Grand Canyon in Arizona, killing all 128 people onboard the two flights. It was the worst aviation disaster to date. The Civil Aeronautics Board (CAB), army helicopter pilots, mountaineering teams, and the National Park Service conducted a challenging recovery effort within two impact sites and a debris area covering over 1,000 acres. Clues from the aircraft wreckage, the distribution of aircraft parts, and interviews with air traffic controllers led the CAB to cite the collision’s probable cause as the failure of the pilots to see one another. Regarded as an important watershed in aviation history, the accident dramatically accelerated movements already underway to address the airways crisis. Public reaction to the tragedy spurred congressional funding in an unprecedented effort to modernize America’s postwar airways with nationwide radar coverage, a common military/civilian navigation system, and new flight rules placing all aircraft above 15,000 feet under

control of ground personnel. Technologies such as collision avoidance systems and flight data recorders were rapidly developed. In August 1957, President Eisenhower signed the Airways Modernization Act, a prelude to the establishment of the independent Federal Aviation Agency (renamed the Federal Aviation Administration in 1967).

Integrity:

- The hundreds of pieces of aircraft material and the evidence of land disturbance that remain in this remote section of the canyon's vast landscape make this property very compelling. The site's isolation conveys a sense of the accident's improbability due to the area's uncongested airspace, the challenges associated with recovering accident victims, and the accident investigation.

Owner of Property: National Park Service

Acreage of Property: 1,332 acres

Origins of Nomination: The National Park Service Intermountain Regional Office (Denver), the Grand Canyon National Park, and the Northern Arizona University developed this nomination.

Potential for Positive Public Response or Reflection on NHL Program:

- Designation as an NHL will assist in protecting and recognizing a seminal event in the nation's postwar airways crisis.

Potential for Negative Public Response or Reflection on NHL Program: None known.

Landmarks Committee Comments: The committee requested that an image or a drawing of the crash be added to the nomination.

Landmarks Committee Recommendation: Designation. Dr. Clark Hine moved, Dr. Murtagh seconded; eight yeas and one abstention.

Public Comments Favoring Designation (received as of 05/24/11):

Barclay C. Trimble, Acting Superintendent, Grand Canyon National Park, National Park Service

Advisory Board Recommendation: Unanimous approval to designate the property as an NHL pending efforts to locate and contact as many descendants as possible to notify them regarding the potential designation.

National Historic Landmark Nomination

(redacted version)

NATIONAL HISTORIC LANDMARK NOMINATION

NPS Form 10-900

USDI/NPS NRHP Registration Form (Rev. 8-86)

OMB No. 1024-0018

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE

Page 1

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

1. NAME OF PROPERTY

Historic Name: 1956 Grand Canyon TWA-United Airlines Aviation Accident Site

Other Name/Site Number: Grand Canyon National Park Archaeological Site AZ:C:13:0755

2. LOCATION

Street & Number: Not for publication: X

City/Town: Grand Canyon National Park Vicinity: _____

State: Arizona County: Coconino Code: 005 Zip Code: 86023

3. CLASSIFICATION

Ownership of Property

Private: _____

Public-Local: _____

Public-State: _____

Public-Federal: X

Category of Property

Building(s): _____

District: _____

Site: X

Structure: _____

Object: _____

Number of Resources within Property

Contributing

3

3

Noncontributing

_____ buildings

_____ sites

_____ structures

_____ objects

_____ Total

Number of Contributing Resources Previously Listed in the National Register: 0

Name of Related Multiple Property Listing: N/A

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE**Page 2**

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

4. STATE/FEDERAL AGENCY CERTIFICATION

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this ____ nomination ____ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ____ meets ____ does not meet the National Register Criteria.

Signature of Certifying Official_____
Date_____
State or Federal Agency and Bureau

In my opinion, the property ____ meets ____ does not meet the National Register criteria.

Signature of Commenting or Other Official_____
Date_____
State or Federal Agency and Bureau**5. NATIONAL PARK SERVICE CERTIFICATION**

I hereby certify that this property is:

- ____ Entered in the National Register
____ Determined eligible for the National Register
____ Determined not eligible for the National Register
____ Removed from the National Register
____ Other (explain):

Signature of Keeper_____
Date of Action

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE**Page 3**

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

6. FUNCTION OR USE

Historic: Transportation

Sub: Air-related

Current: Recreation & Culture

Sub: Outdoor Recreation

7. DESCRIPTION

Architectural Classification: N/A

Materials:

Foundation:

Walls:

Roof:

Other:

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE**Page 4**

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

Summary Statement of Significance

The 1956 Grand Canyon United-TWA Aviation Accident Site meets National Historic Landmark Criterion 1 for its association with the modernization of America's aviation airways. On June 30, 1956, a Trans World Airlines Super Constellation L-1049 and a United Air Lines DC-7 collided in uncongested airspace 21,000 feet over the Grand Canyon in Arizona, killing all 128 people onboard the two flights. Regarded as an important watershed in aviation history, the accident dramatically accelerated movements to address an airway crisis created by improved aircraft technology, the advent of the jet age, increasing traffic in the airspace system, and the fact that little had been done to expand the capacity of the air traffic control system. As a result, in August 1957 President Eisenhower signed the Airways Modernization Act, a prelude to establishing the Federal Aviation Agency.

Describe Present and Historic Physical Appearance

The 1956 Grand Canyon aviation accident site is located within [REDACTED] Grand Canyon National Park [REDACTED]

The TWA Super Constellation crashed at an elevation of 3,200 feet [REDACTED]

The United DC-7 crashed 1¼ miles north of the TWA aircraft at an elevation of 4,000 feet [REDACTED]

Debris from the mid-air collision was scattered over 1.5 square miles east and west of the Colorado River. The site is difficult to access, requiring multiple transit days via hiking trails or the Colorado River.

On the evening of June 30, and again on the morning of July 1, 1956, a local scenic airline pilot spotted intense fires burning at both impact areas.³ After the rescue and recovery operation began, U.S. Army helicopter pilots described two burned accident sites with fragmented aircraft debris. A medic who accompanied the helicopter pilots to both crash sites reported that no one had survived the crashes.⁴ In its Accident Investigation Report released on April 17, 1957, the Civil Aeronautics Board (CAB) concluded that the force of the impact disintegrated the largest components of both aircraft. The severely damaged major components remaining, with the exception of the DC-7's wing tip and the Constellation's rear tail, led investigators to determine how the airplanes had collided above and slightly west of the TWA impact area.⁵ The appearance of the sites has been

¹ Civil Aeronautics Board, *Accident Investigation Report: Trans World Airlines, Inc., Lockheed 1049A, N 6902C, and United Air Lines, Inc., Douglas DC-7, N 6324C, Grand Canyon, Arizona, June 30, 1956*, released April 17, 1957, http://ntl1.specialcollection.net/scripts/ws.dll?file&fn=8&name=S%3A%5CDOT_56GB%5Cairplane%20accidents%5Cwebsearch%5C063056.pdf1 (accessed February 25, 2011), 4.

² National Park Service, Grand Canyon National Park, Division of Science and Resource Management, 2007, archeological site record, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

³ John S. McLaughlin, Superintendent, Grand Canyon National Park to Regional Director, Region Three, "Trans-World Airlines and United Air Lines Crashes, June 30," August 1956 (date stamp), Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁴ Civil Aeronautics Board, *Accident Investigation Report*, 3. Synthetic fabrics, wooden cabinets, trim, luggage and other cargo in the aircraft bodies allowed these fires to burn or smolder for days. AP wire photos, July 2 and July 5, 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ. The accident sites were described in 2000 as "mere blackened scars on an otherwise buff-colored terrain of the canyon walls." Colonel Edgar A. Haine, *Disaster in the Air* (New York: Cornwall Books, 2000), 191.

⁵ Civil Aeronautics Board, *Accident Investigation Report*, 16.

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE**Page 5**

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

impacted by the recovery effort in the immediate aftermath of the accident and the clean-up operations conducted in 1957 and 1976.

TWA Accident Site, 1956

The geographical location of the TWA accident site is a sloping plateau covered with boulders, flat ridges and a drainage channel. The condition and distribution of aircraft parts led the CAB to conclude that the L-1049 Constellation had hit the ground at a deep angle in an inverted position.⁶ The impact produced an extensive mound of burned debris and widely scattered and twisted pieces of aircraft. Hundreds of square feet of blackened ground surface around the impact area,⁷ caused by burning aircraft fuel, was seen from the air. Heavily disturbed soil, rocks, and vegetation appear in 1956 photographs. The largest pieces of aircraft debris were perhaps 25 to 30 feet long, but the majority of debris was much smaller, perhaps one to two feet in maximum dimensions.⁸ CAB officials determined that with few exceptions, “all of the aircraft was at the main wreckage area.”⁹ A map created by the CAB showed the distribution of identifiable pieces of wreckage.¹⁰ From this wreckage, helicopters removed seven large pieces for delivery to Washington, D.C. These pieces included a wing spar, wing flap, a piece of lower wing skin, two sections of right fuselage, a section of rear fuselage, and a piece of upper right side fuselage.¹¹ Recovery personnel also removed the remains of all 70 accident victims, and all but three were interred in a mass grave in Flagstaff, Arizona.¹²

United Accident Site, 1956

The United accident site is located on a bedrock ledge at the top of an 800-foot-high Redwall limestone cliff. The aircraft had impacted the ground with its nose and right wing down, but in a forward position sending multiple fragments west, north, and east into a “deep, narrow canyon” or crevasse.¹³ Otherwise, the United site exhibited the same physical characteristics as the TWA site with hundreds of square feet of blackened ground surface, an extensive mound of burned debris, widely scattered and twisted pieces of aircraft,¹⁴ and heavily disturbed soils, rocks and vegetation. Helicopters removed four pieces of the aircraft wreckage including two sections of engine cowling, a small section of wing skin, and a small section of baggage compartment flooring. Color photographs from July 1956 show a five-man team from the Colorado Mountain Club ascending the cliffs on rappel lines to access the cliff ledge and the large crevasse below the wreckage. Recovery personnel removed the remains of the victims. Twenty-nine of the victims were identified and sent to families for burial. The remaining twenty-nine victims were buried in a mass grave marked by a large stone memorial at the Grand Canyon Pioneer cemetery.

⁶ Ibid.

⁷ AP wire photos, 1, 3 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁸ Estimated dimension is based on photographs with people standing next to the wreckage on the ground. Catalog number 464773, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁹ Civil Aeronautics Board, Bureau of Safety Investigation, *Structural Investigation Report: Aircraft Accident Involving Trans World Airlines L-1049A, N 6902C and United Airlines DC-7, N 5324C at Grand Canyon, Arizona on June 30, 1956* (July 24, 1956), 3.

¹⁰ Ibid. This map is identified in the report as the Wreckage Distribution Chart and is housed in the Grand Canyon National Park Museum Collection. Several dozen individual aircraft pieces, some of which were removed, are depicted in this hand-drafted chart.

¹¹ Ibid.

¹² Haine, *Disaster in the Air*, 197.

¹³ Ibid., 193. No CAB hand-drawn map, as prepared for the TWA site, was made for the United crash site due to its inaccessibility and time constraints. Ian Hough, Grand Canyon National Park, by telephone to Susan Salvatore, National Historic Landmarks Program, March 15, 2011.

¹⁴ AP wire photos, 1, 3 July 1956.

1956 GRAND CANYON TWA-UNITED AIRLINES AVIATION ACCIDENT SITE**Page 6**

United States Department of the Interior, National Park Service

National Register of Historic Places Registration Form

Camp Sites, 1956

Ground operations for the recovery effort were centered at camp sites near each wreckage area and were used by CAB investigators, airline representatives, Grand Canyon National Park officials, recovery personnel, media personnel (reporters and cameramen), and congressional members. These sites served as gear and equipment staging areas, logistics and meeting centers, and eating and sleeping areas for overnight stays. The TWA camp was set up at the edge of the TWA wreckage site. Photographs show this camp as a flat ridge area cleared of boulders to accommodate helicopter landings and equipment. A nearby group of large boulders sheltered the camp from the wind and sun. The United camp was set up in an open area near the edge of a six-foot drop-off. The drop-off and ledge below sheltered the camp from the wind and sun. This camp was also used to prepare victims for recovery with embalming fluids and body bags.

1957 Clean-Up Operation

In the summer of 1957, Phoenix resident Robert Billingsley, supposedly unaware that the crash areas were closed, conducted a trip down the Colorado River during which he examined wreckage from the accident.¹⁵ Upon his return, Billingsley spoke with a local radio station in Phoenix and claimed he had found enough human remains at the sites to “fill a dozen gunny sacks.” He also claimed to have found blackened coins, jewelry, and a TWA spoon.¹⁶ Billingsley repeated his claims to park officials who then coordinated a follow-up investigation and clean-up operation at both accident sites on September 17, 1957.¹⁷ At the TWA site, a clean-up crew collected personal items, buried 15 to 20 pounds of human body fragments at an undisclosed location near the impact area, and turned over three rings to TWA. The tail section, located 1,650 feet from the impact area on the side of a steep ravine, was pushed into the ravine to conceal it from view.¹⁸ At the United site, the crew cut up the DC-7 horizontal stabilizer into four sections and concealed it behind large boulders. Below the impact area, the crew removed 100 feet of climbing rope used in the 1956 recovery operation. Additionally, “numerous other large pieces of wreckage [REDACTED] were concealed.”¹⁹ No human remains were found at the United site.²⁰ Following the clean-up operation, the National Park Service reopened the section of the canyon where the sites are located; however, the crash sites themselves remained closed to hikers.²¹

Although some pieces of both aircraft were removed or relocated in 1956 and 1957, the vast majority of the wreckage including large pieces, such as the TWA tail section, remained at the sites after 1957. A 1960 aerial photo shows a significant amount of wreckage present at the United site.²² Park officials were aware that the

¹⁵ Lynn Coffin, “Meeting with Robert Billingsley,” 15 August 1957, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

¹⁶ “Statements by Mr. Close on KOY Radio Station,” Phoenix, 7:15 A.M. Broadcast, 7 August 1957, Grand Canyon National Park Museum Collection, Grand Canyon, AZ. Billingsley removed two rings from the site.

¹⁷ Coffin, “Meeting with Robert Billingsley.”

¹⁸ Lynn Coffin to the Superintendent, “Clean-up of UAL-TWA Crash Sites, September 17-18,” 17-18 September 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

¹⁹ Ibid.

²⁰ Lynn Coffin to Edgar Howbert, Dickinson, Wright, Davis, McKean & Cudlip Counsellors at Law, 18 October 1957, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

²¹ John McLaughlin, “Superintendent’s Order No. 2-57,” 20 September 1957; Merle Stitt, Superintendent, Grand Canyon National Park to Ellsworth Perry, Regional Vice President, United Airlines, 21 May 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

²² P. T. Reily, United Airlines crash site aerial photo, 1960.

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aircraft wreckage attracted attention and noted that “many persons” visited the sites annually despite the restrictions on the area and potentially removed or disturbed artifacts despite restrictions on the area.²³

1976 Clean-Up Operation

By the twentieth anniversary of the aviation accident, growing use of the park and a national anti-litter campaign pushed officials to further clean up both accident sites.²⁴ According to then Assistant Superintendent Bruce Shaw, the wreckage had become “an attractive nuisance” that drew “sensation-seekers” hoping to find “all kinds of morbid things.”²⁵ In the mid-1970s, park officials began negotiating with TWA and United Airlines to remove aircraft debris.²⁶ In October 1976, the National Park Service contracted with a salvage firm to remove the remaining large pieces of aircraft wreckage. According to Superintendent Shaw, the operation involved “removing the few large hunks of metal by helicopter, then raking the other debris into containers and flying it to trucks at the canyon rim.”²⁷ Helicopters made over 70 trips to remove approximately 20,000 to 30,000 pounds of aluminum²⁸ including most of the larger pieces of the Constellation wreckage.²⁹

At the United site, “four engines, one landing gear, one wing rib, several other large pieces of wing sections, numerous pieces (small pieces up to the size of a desk) on the north and east side of the impact area” were removed as well as “several large pieces on top of the back slope.”³⁰ Climbers evidently helped to remove wreckage, using cables to hook pieces in inaccessible locations for retrieval and kicking large pieces over the edge where they could be reached for removal.³¹ A vertical stabilizer or aileron lying between the crash sites was also removed. “Very little in the way of personal property” was found at the United site and “only a small quantity of human bone,” was recovered and turned over to the Coconino County Coroner.³² According to an administrative report, by the end of October the salvage operation was complete.³³

Current TWA Accident Site

The TWA site includes the impact area and the immediately surrounding debris field. Contained within this site is the recovery operations camp located adjacent to the impact area. The blackened ground surface caused by

²³ Stitt to Perry, 21 May 1976.

²⁴ Lyle McDowell, Acting Regional Director, Western Region to Associate Director, Park System Management, National Park Service, “TWA and United Airlines Aircraft Wreckage from 1956 Crash,” 9 July 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ; Merle Stitt to Regional Director, Western Region, “TWA and United Airlines Aircraft Wreckage from 1956 Crash,” 30 June 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

²⁵ Stitt to Regional Director, Western Region, “TWA and United Airlines Aircraft Wreckage from 1956 Crash,” 8 July 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ. In Shaw’s opinion, this situation put the fragile desert plants and soils at risk.

²⁶ Merle Stitt to Richard Street, Assistant General Counsel, United Airlines, 12 August 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ; Alexander Moody, Attorney for United Airlines to Merle Stitt, 17 September 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

²⁷ *The Denver Post*, 8 August 1976.

²⁸ *Arizona Republic*, 13 October 1976.

²⁹ Assistant Superintendent’s Files, “TWA and United Crash Clean-Up,” 6-7 October 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

³⁰ *Ibid.*

³¹ *Arizona Republic*, 13 October 1976.

³² Merle Stitt to Alexander Moody, Attorney for United Airlines, 28 October 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ; Merle Stitt to Dale Medland, Vice President, United Airlines, 28 October 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

³³ “Daily Report,” Grand Canyon National Park, 29 October 1976, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

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the crash is no longer visible. The impact area contains a two-foot deep crater (.10 acres) and heavily disturbed ground area [REDACTED]

[REDACTED] Intensely burned main cabin debris is located mostly in the bottom of a small drainage within the impact area. [REDACTED]

The TWA recovery operations camp used in 1956 and 1957 contains a cluster of boulders at the southwest edge of a flat ridge immediately east of the TWA debris field. [REDACTED]

Current United Accident Site

The United impact area is similar to the TWA impact area in terms of a recognizable impact crater, heavily disturbed ground surface, [REDACTED] The majority of the wreckage, [REDACTED] located in the burned impact area and the ridge directly above it. The impact area contains a one- to three-foot deep crater characterized by blackened soil, rock, melted aluminum puddles, [REDACTED]

³⁴ Ibid.

³⁵ Kimberly Spurr, "In-Field Inventory of Human Remains at AZ C:13:755," Past Peoples Consulting, 6 October 2006, 3.

³⁶ Grand Canyon National Park, Division of Science and Resource Management, 2007, archeological site record, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

³⁷ Ian Hough, archeological site documentation field notes, 15-16 November 2008, Division of Science and Resource Management, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

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[REDACTED]

The United debris field covers [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] were blown clear of the impact explosion and likely remain today where they landed in 1956 based on their proximity to the impact crater and the fact that they are twisted and torn, but not burned.

[REDACTED]

The United recovery operations camp contains three and possibly four discrete areas immediately west of the impact site. [REDACTED]

[REDACTED]

Aspects of Integrity

The 1956 Grand Canyon Aviation Accident Site is nationally significant for its direct association with the modernization of American aviation safety regulations. This association is demonstrated by the landscape, [REDACTED] that portray a traumatic accident. Therefore, the aspects of location, setting, materials, feeling, and association are the essential elements needed to convey the site's significance.

Location. The area of the Grand Canyon [REDACTED] is the exact location of the 1956 mid-air aviation accident. The site is a remote section of the canyon's vast landscape that conveys a sense of the accident's improbability, the challenges associated with recovering accident victims, and the accident investigation.

Setting. The physical environment of the accident site, characterized by the surrounding canyon landscape, has not changed. The site is located within [REDACTED] Grand Canyon National Park [REDACTED]

[REDACTED]

The United impact site and debris field [REDACTED]

[REDACTED] The setting of both wreckage sites conveys a strong sense of remoteness and isolation.

³⁸ Ibid.

³⁹ Ibid. The bottle caps with the word "Dodge" have not been positively identified as such, but Dodge Company has been a major manufacturer of embalming fluid since the 1930s.

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Materials. Materials located at the two aircraft impact sites [REDACTED]

[REDACTED]

Feeling. The overwhelming feeling of an aviation accident exists at this site, especially at the impact areas. The burned and twisted wreckage [REDACTED] extremely rugged terrain and isolated location strongly convey the sense that the accident produced a tragic loss of life in a seemingly vast, open and safe airway.

Association. The 1956 aviation accident can be directly related to the two impact areas, debris fields and recovery camps. This is supported by material remains dated to 1956, photographs of the accident sites that show the airlines wreckage, and eyewitness accounts of the sites. [REDACTED]

[REDACTED]

Contributing Resources

1. TWA Impact Area. This resource includes the site of impact where large sections of the Constellation were deposited upon impact, the immediately surrounding debris field where material fell to the ground after the mid-air collision, and the adjacent recovery camp.
2. United Impact Area. This resource includes the site of impact where large sections of the DC-7 were deposited upon impact, the immediately surrounding debris field where material fell to the ground after the mid-air collision, the adjacent recovery camp, and rappel lines.
3. Greater Debris Area. This resource includes the greater area surrounding the TWA and United impact areas with known distribution of wreckage and other items that came to rest away from the impact areas and the immediately surrounding debris field.

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8. STATEMENT OF SIGNIFICANCE

Certifying official has considered the significance of this property in relation to other properties:

Nationally:___ Statewide:___ Locally:___

Applicable National

Register Criteria: A x B___ C___ D___

Criteria Considerations

(Exceptions): A___ B___ C___ D___ E___ F___ G___

NHL Criteria: 1

NHL Theme(s): V. Developing the American Economy: transportation and communication

Areas of Significance: Transportation, Politics/Government

Period(s) of Significance: June 30, 1956 – July 12, 1956 (the accident date through the immediate recovery effort and accident investigation)

Significant Dates: June 30, 1956 (accident date)

Significant Person(s): NA

Cultural Affiliation: NA

Architect/Builder: NA

Historic Contexts: American Aviation Heritage National Historic Landmarks Theme Study (2011)

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State Significance of Property, and Justify Criteria, Criteria Considerations, and Areas and Periods of Significance Noted Above.

The 1956 Grand Canyon United-TWA Aviation Accident Site meets National Historic Landmark Criterion 1 for its association with the modernization of America's aviation airways. On June 30, 1956, a Trans World Airlines Super Constellation L-1049 and a United Air Lines DC-7 collided in uncongested airspace 21,000 feet over the Grand Canyon in Arizona, killing all 128 people onboard the two flights. Regarded as an important watershed in aviation history, the accident dramatically accelerated movements to address an airway crisis created by improved aircraft technology, the advent of the jet age, increasing traffic in the airspace system, and the fact that little had been done to expand the capacity of the air traffic control system. As a result, in August 1957 President Eisenhower signed the Airways Modernization Act; a prelude to establishing the Federal Aviation Agency (renamed the Federal Aviation Administration in 1967).

The Grand Canyon aviation accident site portrays a unique and powerful cultural landscape. Its two impact sites, and the artifacts strewn over 1,000 acres, project a compelling sense of intense tragedy. These features define the watershed accident and give meaning to the postwar airway crisis and the need for immediate reform.

In the decade after World War II, congested airspace and inadequate aviation facilities caused an "airways crisis." In this situation, civilian and military aircraft operated under separate air traffic control systems, and pilots in uncontrolled airspace flew under the "see and be seen" principle with little or no external traffic control assistance. Under the latter situation, the TWA Constellation and the United DC-7 collided in midair over the Grand Canyon, becoming the worst aviation disaster to date. The accident highlighted the ineffectiveness of the Civil Aeronautics Agency's (CAA) handling of aviation safety and partly led to the passage of the Federal Aviation Act of 1958, which created the independent Federal Aviation Agency.⁴⁰ Public reaction to the tragedy spurred increased congressional funding in an unprecedented effort to modernize America's postwar airways with nationwide radar coverage, a common military/civilian navigation system, and new flight rules placing all aircraft above 15,000 feet under control of ground personnel.⁴¹ In addition, technologies such as collision avoidance systems and flight data recorders rapidly developed.⁴²

Historic Context**Pioneering Aerial Navigation**

Limited federal oversight of air travel in the United States has its origins in mail delivery. After the First World War, the Post Office Department turned its wartime experiments into an Air Mail Service staffed with former military pilots and surplus war planes. Without an air traffic control system in 1918, pilots used magnetic compasses and followed landmarks, railroads, and roadways to reach their destinations.⁴³ In 1921, ten radar stations between New York and San Francisco served as a pilot's first navigation tools. In 1923, the Post

⁴⁰ Roger E. Bilstein, *Flight in America: From the Wrights to the Astronauts* (London: The John Hopkins University Press, 2001), 232; Michael McComb, "Collision Over the Canyon: Half a Century Onward," *Airways* 13 (August 2006): 53. The FAA changed its name to the Federal Aviation Administration in 1967.

⁴¹ Stuart I. Rochester, *Takeoff at Mid-Century: Federal Civil Aviation Policy in the Eisenhower Years, 1953-1961* (Washington, DC: U.S. Department of Transportation, Federal Aviation Administration, 1976), 130; Gordon Murphy, "The Grand Canyon Midair Collision: A Stimulus for Change," *The American Journal of Forensic Medicine and Pathology* 11, 2 (1990): 102.

⁴² Michael McComb, "Desert Disaster: TWA-United Mid-Air Collision over the Grand Canyon," *America's Flyways* (June 2006), 25.

⁴³ Carl Solberg, *Conquest of the Skies: A History of Commercial Aviation in America* (Boston: Brown and Company, 1979), 20.

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Office Department began installing a system of beacons placed on towers every ten miles along the transcontinental airway.⁴⁴

During the 1920s, airmail operations helped create the U.S. commercial aviation industry. The Air Mail Act of 1925 awarded lucrative federal mail contracts to commercial operators and spawned such long-standing companies as American, United, and Eastern Airlines.⁴⁵ As air travel increased, aviation leaders pressed for federal oversight to improve and maintain safety standards. The ensuing 1926 Air Commerce Act made the Secretary of Commerce responsible for fostering air commerce, operating and maintaining aids to air navigation, and investigating accidents. Under this act, the newly established Aeronautics Branch in the Commerce Department assumed the Post Office Department's responsibility for maintaining and completing the transcontinental lighted airway, charting airways, establishing air traffic rules, and licensing pilots and their aircraft.⁴⁶

Charles Lindbergh's historic flight over the Atlantic in 1927 touched off an aviation craze and ushered in a new era of air travel. Money poured into both airline stocks and technological innovations such as air-cooled engines, aluminum skin, and monoplane design.⁴⁷ Between 1926 and 1930, passenger air travel increased from 5,800 passengers per year to 417,000.⁴⁸ The March 1931 high profile crash of a Transcontinental and Western Air (TWA) wooden tri-motor airplane that killed nine, including famed Notre Dame football coach Knute Rockne, spelled the end of wooden aircraft. The Aeronautics Branch discovered that moisture inside the wing had deteriorated the glue and weakened the wing. Thereafter, Boeing and Douglas produced revolutionary aircraft that were 50 percent faster than their predecessors, initiating the era of the modern airliner.⁴⁹

Using a new generation of airplanes and prodded by a sharp reduction in mail contracts, airlines in the 1930s began to shift from hauling mail to carrying passengers for increased revenues.⁵⁰ Introduction of the DC-3 and its lower operating costs significantly reduced air fares and proved especially attractive to business travelers.⁵¹ In 1938 a little over one million Americans chose to fly while 15 million traveled by Pullman train cars.⁵² Two years later passenger air traffic tripled as over three million people took to the skies.⁵³

This dramatic increase in passenger travel, coupled with the 1935 crash of a TWA DC-2 that killed five, including Senator Bronson Cutting of New Mexico, led Congress to reorganize civil aviation. A Senate

⁴⁴ Theresa L. Kraus, *The Federal Aviation Administration: A Historical Perspective, 1903-2008* (Washington, DC: U.S. Department of Transportation, Federal Aviation Administration, 2008), 1.

⁴⁵ Roger E. Bilstein, "Air Travel and the Traveling Public: The American Experience, 1920-1970," in *From Airships to Airbus: The History of Civil and Commercial Aviation*, ed. William Trimble, vol. 2, *Pioneers and Operations* (Washington, DC: Smithsonian Institution Press, 1995), 92.

⁴⁶ Nick A. Komons, *Bonfires to Beacons: Federal Civil Aviation Policy Under the Air Commerce Act, 1926-1938* (Washington, DC: U.S. Department of Transportation, Federal Aviation Administration, 1978), 84-88, 91-93, 144 for commentary. By 1933 the Airways Division of the Department of Commerce had completed 18,000 miles of lighted airways, installed 1,550 light beacons, and constructed over 250 airfields.

⁴⁷ Heppenheimer, *Turbulent Skies*, 44-45; Solberg, *Conquest of the Skies*, 72.

⁴⁸ Heppenheimer, *Turbulent Skies*, 14; Solberg, *Conquest of the Skies*, 22.

⁴⁹ Susan Cianci Salvatore, John D. Anderson Jr., Janet Daly Bednarek, Roger Bilstein, Caridad de la Vega, Marie Lanser Beck, and Laura Shick, *American Aviation Heritage: Identifying and Evaluating Nationally Significant Properties in U.S. Aviation History* (Washington, DC: U.S. Department of the Interior, National Park Service, 2011), 100-01.

⁵⁰ Heppenheimer, *Turbulent Skies*, 64, commentary on 45. The 1930 McNary-Watres Act cut mail-pay rates, the main source of revenue for the airlines. A 1934 scandal over mail route contracts resulted in a second Air Mail Act that further reduced mail rates, slashing postal revenue for the airlines by half.

⁵¹ *Ibid.*, 72.

⁵² Bilstein, "Air Travel and the Traveling Public," 97.

⁵³ Heppenheimer, *Turbulent Skies*, 72.

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investigation into the accident placed some blame on the Aeronautics Branch, citing problems “with the bureau’s procedures and navigation aids.”⁵⁴ As a result, in 1938, President Franklin Roosevelt signed the Civil Aeronautics Act vesting responsibility for the nation’s airways in an independent Civil Aeronautics Authority (CAA). Although the new authority addressed safety concerns and eliminated the inefficiencies of the old airmail contract system, it was a cumbersome tripartite organization that ultimately proved unable to meet the aeronautic challenges of the postwar era.⁵⁵ In 1940 President Roosevelt addressed aviation regulation further and divided the CAA into two agencies, the Civil Aeronautics Administration and the Civil Aeronautics Board (CAB). “The CAA returned to the Department of Commerce and was tasked with overseeing ATC [air traffic control], pilot and aircraft certification, safety enforcement, and airway development. The CAB became responsible for accident investigations, safety rulemaking, and economic regulation of the airlines.”⁵⁶

The Airways Crisis

While World War II dramatized the airplane’s potential, an unprecedented surge in postwar air travel caught both the airlines and government unprepared. Dramatic wartime technological advances and increased production had provided airlines with aircraft possessing higher cruising speeds than pre-war aircraft. Airports became more congested and the increasing popularity of private flying further saturated air space.⁵⁷ Without radar and the ability to directly communicate with pilots, the skies above major airports became dangerously crowded⁵⁸ and by the late 1940s, air traffic volume outstripped the capacity of the existing navigation and traffic control systems.⁵⁹ The “airways crisis,” caused by the phenomenal growth of private, military, and commercial aviation “began to strain the thin network of navigation and traffic control facilities that guided planes on the Federal airways.”⁶⁰

The year 1947 then became the “worst single year in air transport history.” Of thirty-six domestic accidents, five proved fatal. That summer, after 143 people died during a two-week period, President Truman took action, appointing leaders of all the main aviation agencies to a Special Board of Inquiry on Air Safety. On December 29, 1947, the group delivered its inconclusive final report. No common cause could be identified for all the crashes. Rather the causes included malfunctioning aircraft systems, pilot error, faulty meteorological reporting, and bad airway control.⁶¹

Efforts to address the airways crisis continued when, in 1948, the House Commerce Committee tasked the Radio Technical Commission for Aeronautics, a quasi-governmental advisory group, to map an airways facilities plan. The agency’s report, known as SC-31 (Special Committee 31) “cited a critical need for additional navigation aids, improved air-to-ground communications, modernized traffic control procedures, and above all, a single, integrated ‘common’ system to serve and regulate both civil and military users.”⁶² The outbreak of the Korean War in 1950 hampered the progress of SC-31. Ignoring the need for a common system,

⁵⁴ Salvatore, et al, *American Aviation Heritage*, 119; Komons, *Bonfires to Beacons*, 277-78.

⁵⁵ Komons, *Bonfires to Beacons*, 347, 378-79.

⁵⁶ Federal Aviation Administration, “The History of the FAA,” http://www.faa.gov/about/history/brief_history/ (accessed February 28, 2011); also see Kraus, *Federal Aviation Administration*, 4-5.

⁵⁷ R. E. G. Davies, *Airlines of the United States Since 1914* (Washington, DC: Smithsonian Institution Press, 1972), 354. During the war, 1.5 million Americans had learned to fly and a million more military personnel flew as passengers. By 1948 reduced prices on coach air service made flying affordable to middle-class Americans. Solberg, *Conquest of the Skies*, 323.

⁵⁸ Solberg, *Conquest of the Skies*, 336-37.

⁵⁹ Rochester, *Takeoff at Mid-Century*, 57. A 1948 Commerce Department report found the air traffic control and navigation system to be overloaded and incapable of handling any more than 42 percent of the current traffic. Heppenheimer, *Turbulent Skies*, 136.

⁶⁰ Rochester, *Takeoff at Mid-Century*, 57.

⁶¹ Davies, *Airlines of the United States*, 330-31.

⁶² Rochester, *Takeoff at Mid-Century*, 57-58.

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military planners began to construct their own parallel air traffic control system, Tactical Air Navigation System, also known as TACAN. Meanwhile the CAA continued to develop its air traffic control system, VOR/Distance Measuring Equipment (DME), although it was incompatible with TACAN equipment. The parallel development of these two incompatible systems, and the ensuing debate over which technology was best suited for a common system, prevented badly needed reforms. The 1953 election of Dwight Eisenhower simply compounded these problems. The new president fulfilled his promise to cut government spending. In 1954, Eisenhower reduced CAA appropriations to \$71 million below 1951 levels. During the same period, spending on the SC-31 recommendations declined from \$37 million to \$5 million.⁶³

From 1938 to 1953, as the number of annual airline passenger miles increased 1,800 percent, plans like SC-31 failed to adequately modernize the air traffic control system as the airline industry experienced phenomenal growth. In 1952, airlines hauled 25 million Americans, nearly one-sixth of the population.⁶⁴ New larger airplanes from Douglas and Lockheed moved more passengers at speeds exceeding 300 mph. Domestic airlines finally surpassed Pullman service in 1955 and in 1956 more Americans traveled by plane than by train.⁶⁵ In that year, the “Big Four” airlines (American, Eastern, United, and TWA) were each bigger than the entire industry had been only a decade before.⁶⁶

Although most people remained unaware of the true magnitude of the crisis gripping America’s airways, this transportation revolution alarmed industry experts and government officials who understood the air traffic control system was outdated. As 1955 passed without a single passenger fatality in scheduled domestic operations, a sense of false security developed. Yet, repeated warnings of air disasters did appear. Between 1950 and 1955, 65 mid-air collisions involving light planes occurred in the United States but these accidents, typically involving around 50 fatalities, failed to illicit immediate reform.⁶⁷

Early Reform Efforts

The perception that the air traffic control system was increasingly inadequate caused some government officials and industry experts to call for reform. President Eisenhower, as he later related, “received reports that the increasing speed of aircraft, the rapid growth in the volume of daily flights, and the introduction into common use of jet and vertical lift aircraft were causing serious congestion in the airspace.” He also learned that aviation facilities would quickly become outdated for efficient air traffic management.⁶⁸ In May 1955, at the president’s request, the Director of the Bureau of the Budget authorized the formation of the Aviation Facilities Study Group to assess the need for new federal oversight of airspace and future aviation facilities.⁶⁹ The group’s findings, known as the Harding Report after William Barclay Harding who headed the group, were issued to the bureau’s director on December 31, 1955. According to the report, overcrowded airspace already existed and the development of airports, navigation aids, and the air traffic control system lagged far behind aeronautical developments.⁷⁰ “The risks of mid-air collisions,” the report warned, “have already reached

⁶³ Heppenheimer, *Turbulent Skies*, 174-75.

⁶⁴ Rochester, *Takeoff at Mid-Century*, 3-4.

⁶⁵ Solberg, *Conquest of the Skies*, 346.

⁶⁶ Heppenheimer, *Turbulent Skies*, 170.

⁶⁷ Edmund Preston, ed., *FAA Historical Chronology: Civil Aviation and the Federal Government, 1926-1996* (Washington, DC: Department of Transportation, Federal Aviation Administration, August 1998), 54; Rochester, *Takeoff at Mid-Century*, 61, 63.

⁶⁸ “Dwight D. Eisenhower: Special Message to the Congress Recommending the Establishment of a Federal Aviation Agency,” June 13, 1958, in John T. Woolley and Gerhard Peters, *The American Presidency Project*, Santa Barbara, CA, <http://www.presidency.ucsb.edu/ws/index.php?pid=11091> (accessed March 15, 2011).

⁶⁹ Preston, *FAA Historical Chronology*, xiii.

⁷⁰ “Dwight D. Eisenhower: Special Message to the Congress.” Harding was a Wall Street broker and experienced aviator.

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critical proportions,” and airline operations are “flagrantly defying the law of averages.”⁷¹

Implementing the Harding Report’s recommendations fell to Edward P. Curtis who President Eisenhower had appointed in February 1956 to serve as his special assistant for aviation facilities planning.⁷² Curtis was tasked with preparing “legislative, organization, administrative and budgetary recommendations to implement the comprehensive plan.” No stranger to aviation, Curtis had served in the Air Corps in World War I and in World War II risen to the rank of major general. “In time, the Harding report would prove to be a cornerstone and Edward Curtis a skilled architect in the remodeling of Federal aviation policy and the creation of a new aeronautics agency.” Until then, a chorus of pilots echoed the Harding Report’s warning, including Leo Kriloff who, in April 1956, lamented, “The dread specter of a mid-air collision...is not only a possibility—it’s an absolute certainty under present rules. The only question is where and when.”⁷³

The 1956 Grand Canyon Mid-Air Collision

As Curtis prepared his plan, the nation was shocked by a costly civil air disaster. On Saturday morning, June 30, 1956, two airliners took off from Los Angeles International Airport about three minutes apart. At 9:01 a.m. (PST), Trans World Airlines Flight 2, a Super Constellation bound for Kansas City, Missouri, departed with sixty-four passengers and six crew members. At 9:04 a.m., United Air Lines Flight 718, a DC-7 carrying fifty-three passengers and five crew members, departed for Chicago, Illinois. Both four-engine transports traveled on somewhat parallel flying routes,⁷⁴ the TWA flight at 19,000 feet and the United flight at 21,000 feet.⁷⁵ Trans World Airlines Captain Jack Gandy had flown this particular route about 177 times and was well qualified with nearly 15,000 flying hours. United Airlines Captain Robert F. Shirley had flown the route on a regular basis since October 1, 1955, and was also well qualified with nearly 17,000 flying hours.⁷⁶

At 9:21 a.m., over the Mojave Desert near the California-Arizona border, the TWA flight requested permission from the Los Angeles Air Traffic Control center to ascend from 19,000 feet to 21,000 feet to avoid bad weather. Ground control advised the TWA pilot of United’s presence at that level. The TWA flight then asked and received approval to ascend 1,000 feet on top (above the general cloud layer) for better weather. At 10:13 a.m., both pilots relayed their positions at an elevation of 21,000 feet to the Salt Lake City controller, and estimated arrival at the Painted Desert point of reference near Winslow, Arizona, at 10:31.⁷⁷

About the time they crossed the California border, the two aircraft had passed from controlled instrument flight rules (IFR) along prescribed airways, to visual flight rules (VFR) whereby pilots became responsible for avoiding other aircraft. The Super Constellation was traveling at about 310 mph, and the DC-7 at approximately 330 mph.⁷⁸ The last radio message at 10:31, unidentifiable at the time, was later interpreted as, “Salt Lake, United 718...ah...we’re going in.”⁷⁹

⁷¹ Rochester, *Takeoff at Mid-Century*, 121.

⁷² “Dwight D. Eisenhower: Special Message to the Congress Agency.”

⁷³ Rochester, *Takeoff at Mid-Century*, 123, 125.

⁷⁴ Haine, *Disaster in the Air*, 190; David Gero, *Aviation Disasters: The World’s Major Civil Airliner Crashes since 1950* (Great Britain: Patrick Stephens Limited, 2006), 23.

⁷⁵ Rochester, *Takeoff at Mid-Century*, 126. “Preparations for Flight 2 were routine except that departure was delayed a few minutes by minor maintenance on the aircraft.” CAB, *Accident Investigation Report*, 1.

⁷⁶ CAB, *Accident Investigation Report*, 7.

⁷⁷ Gero, *Aviation Disasters*, 23, 24 for commentary; Haine, *Disaster in the Air*, 190. The Painted Desert was “an imaginary line demarcated by two navigation aids that stretched north-westwards from Winslow, Arizona, into southern Utah.”

⁷⁸ Gero, *Aviation Disasters*, 23-24; Rochester, *Takeoff at Mid-Century*, 127.

⁷⁹ Civil Aeronautics Board, *Accident Investigation Report* 3.

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A search for the two airliners commenced after the pilots failed to report passing the Painted Desert line of position. Following a radio search by communications stations along the route, the CAA and TWA and United communication centers issued a missing aircraft alert at 11:51 a.m. and a search and rescue operation began from Nellis Air Force Base in North Las Vegas, Nevada.⁸⁰ Aircraft from California and Arizona airfields started scouring the Grand Canyon area for any sign of the missing aircraft.⁸¹ That evening Palen Huggins, a pilot for Grand Canyon Airlines, a sight-seeing service, identified the TWA Constellation empennage (the tail assembly), and on the next day he located the United crash site approximately one mile away.⁸² Park rangers relayed Huggins' findings to Nellis and on July 1, air search and rescue units shifted their base of operations to Grand Canyon Airport.⁸³

Military units from across the south and southwest participated in the recovery and investigation operations. At least two army H-19 helicopters from Douglas Airbase, one air force H-21 helicopter from Nellis, two H-21s from Luke Air Force Base, Arizona, and one helicopter from March Airfield, California, joined the operation.⁸⁴ Army crews from the 14th Fixed Wing Tactical Transport Company and the 93rd Cargo Helicopter Squadron at Ft. Huachuca, Arizona,⁸⁵ were later joined by a helicopter detachment from Fort Benning, Georgia. Representatives from the airlines, the CAB, the CAA, the Federal Bureau of Investigation and the Post Office Department joined military personnel on the canyon's South Rim.

On July 1 an air force helicopter briefly landed under hazardous conditions near the TWA wreckage.⁸⁶ High winds prevented landing at the United wreckage [REDACTED].⁸⁷ The rescue team quickly determined that no one had survived the disaster. On July 2, an eleven-person recovery party (including the county coroner, CAB, CAA, and airline officials) flew by helicopter [REDACTED] and landed on a small ledge 150 feet from the TWA crash site.⁸⁸ They collected bodies in rubber sacks and transported five victims to Grand Canyon Airport. From the airport, a DC-3 flew the bodies to a temporary morgue at the Flagstaff fair grounds.⁸⁹ The recovery crew remained in the canyon overnight after high winds made their return too dangerous.⁹⁰

On July 3, the recovery party retrieved another 21 bags of human remains from the TWA crash site.⁹¹ This dangerous work concluded body recovery at TWA, but crews continued to collect personal items and plane

⁸⁰ Ibid.

⁸¹ *Arizona Republic*, 1 July 1956.

⁸² Civil Aeronautics Board, *Accident Investigation Report*, 3.

⁸³ During the night of June 30-July 1, search and rescue was based in Winslow, Arizona. It appears that operations shifted to Grand Canyon Airport after Huggins' second flight on the morning of July 1 when he identified the United plane [REDACTED] Merle Stitt to Regional Director, Region Three, Grand Canyon National Park, July 18, 1956.

⁸⁴ Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, [handwritten notes, no title], 30 June-1 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ; Civil Aeronautics Board, *Accident Investigation Report*, 4.

⁸⁵ *Arizona Republic*, 3 August 1956.

⁸⁶ Civil Aeronautics Board, *Accident Investigation Report*, 4.

⁸⁷ *Arizona Daily Sun*, 2 July 1956; Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, "KB7724-10:05 a.m. - Davis," 1 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁸⁸ Larry Wren, "Gory Crash Scene Detailed by Larry Wren," *Arizona Daily Sun*, 4 July 1956, 1; Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, "Telephone-11:20-from Cravey H.T.," 2 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁸⁹ Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, [handwritten notes, no title], 3 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁹⁰ *Arizona Daily Sun*, 2 July 1956.

⁹¹ Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, "KOC 7724- Airport from Carl-7:55a.m.," 3 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ; *Arizona Daily Sun*, 3 July 1956.

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pieces for the CAB investigation until July 7.⁹² The remains of only three people were ever identified from the TWA site. The unidentified remains of the 67 other passengers and crew were buried in a mass grave, designated the Grand Canyon Memorial Cemetery, at Flagstaff on July 9.⁹³

On July 3, another recovery party also collected two bags of human remains [REDACTED] below the United impact site.⁹⁴ At this point few victims from the United flight had been recovered and it was unclear whether the impact area atop a sheer cliff face could be reached.⁹⁵ United Airlines hired a Swiss mountain team, sharing expenses with Swissair, to help recover victims.⁹⁶ Meanwhile a five-man team of Colorado Mountain Club mountaineers, also hired by United, began scaling the cliff. The ascent was extremely hazardous according to one team member: "the rock was quite rotten...I sure hope I never see anything like that again."⁹⁷ By July 4, three victims had been recovered from the base of the cliff, but neither the climbers nor the helicopter crews had reached the impact area. Following another abortive attempt to land near the wreckage, officials began to discuss the possibility of cancelling further recovery efforts because of the hazardous flying conditions.⁹⁸

On July 5, after driving hundreds of expansion bolts into the soft rock, the climbing team neared the United impact area. Army helicopter pilots Capt. Walter Spriggs and Chief Warrant Officer Howard Proctor also made a treacherous landing, about 150 feet from the wreckage. Spriggs directed the landing of a second helicopter carrying two Colorado mountain climbers. Five more men arrived the following day. On July 6, the Swiss Mountain team arrived with specialized gear. By July 10, the recovery crew had removed 43 bags of remains. The next day, Park Superintendent John McLaughlin terminated recovery efforts.⁹⁹ Eventually 29 of the 58 crash victims were identified and sent to relatives for private burial. On July 12, the remains of the 29 unidentified passengers from the United flight were buried in four coffins at the Grand Canyon Cemetery on the South Rim.¹⁰⁰

Treacherous terrain, high winds, and extreme temperatures created such dangerous flying and working conditions that some experts had deemed the recovery operation impossible.¹⁰¹ Superheated air created 60 mph winds below the rim, tossing the fragile helicopters perilously close to the canyon walls.¹⁰² Temperatures on the canyon floor of 120 degrees challenged man and machine and limited helicopter landings to the early morning hours when the air was cool enough to provide the rotors with lift. One of the Colorado Mountaineers recalled that: "sometimes we only had a few seconds to unload supplies and load on bodies."¹⁰³ The rushing Colorado River provided the only possible emergency landing spot once the helicopters descended below the rim. As Captain Spriggs explained to reporters: "If you misjudge the distance [at United] by 10 or 15 feet, you would drop maybe 1,000 feet into the canyon."¹⁰⁴ Not a single life or aircraft perished during the 76 flights to

⁹² *Arizona Daily Sun*, 3 July 1956; *Arizona Republic*, 7 July 1956.

⁹³ *Los Angeles Examiner*, 10 July 1956; Haine, *Disaster in the Air*, 196.

⁹⁴ Iverson, "KOC 7724-Airport from Carl-7:55a.m."; *Arizona Daily Sun*, 3 July 1956.

⁹⁵ Phil Iverson, Grand Canyon National Park Telephone and Radio Notes, "KB7724-Airport from Carl-9:30 a.m.," 3 July 1956, Grand Canyon National Park Museum Collection, Grand Canyon, AZ.

⁹⁶ *Arizona Daily Sun*, 3 July, 1956; Haine, *Disaster in the Air*, 196.

⁹⁷ *Rocky Mountain News*, 6 July 1956.

⁹⁸ *Arizona Daily Sun*, 4, 5 July 1956

⁹⁹ *Ibid.*, 5, 6, 10, 11 July 1956; *Arizona Republic*, 6 July 1956; Haine, *Disaster in the Air*, 197.

¹⁰⁰ John S. McLaughlin, Superintendent, Grand Canyon National Park to Regional Director, Region Three, 18 July 1956, 5.

¹⁰¹ *Arizona Republic*, 30 July 1956.

¹⁰² "After Commercial Aviation's Worst Disaster: A Perilous Searching Operation," *Life*, 16 July 1956.

¹⁰³ *Rocky Mountain News*, 6 July 1956.

¹⁰⁴ *Arizona Republic*, 6 July 1956.

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and from the crash sites.¹⁰⁵ The extraordinary airmanship and daring of the helicopter crews was recognized as “without precedent in army history” and resulted in numerous commendations and medals.¹⁰⁶

Structural Investigation

The results of the structural investigation led the CAB to conclude that an inflight collision had occurred. “Smears” and paint or “paint smudges” from the Constellation L-1049 appeared on the DC-7’s left outer wing panel, wing tip assembly, and a buckled aileron. A section of the DC-7’s lower wing skin found in the TWA impact area revealed a piece of the L-1049’s headlining used in the cabin. The L-1049 aft fuselage bore three propeller cuts. One of these cuts contained red and blue paint marks that matched the paint scheme on the DC-7’s propeller.¹⁰⁷

Wreckage location, combined with physical damage, also provided clues to an inflight collision. Severe damage on the L-1049 main empennage, found 550 yards north of the aircraft’s impact area, revealed that it had separated from the aft fuselage in flight after colliding with the DC-7. Two pieces from the Constellation empennage were located far enough from the main empennage to indicate separation prior to ground impact. “Heavier pieces of the L-1049 aft fuselage structure and aft interior equipment were found west of the main TWA wreckage site. Light interior materials from the aft fuselage [REDACTED] indicating that they were torn or spilled out at a sufficient altitude to drift this distance.”

Based on a thorough analysis of physical damage and the location of aircraft wreckage, the CAB formulated its inflight collision sequence:

[I]t appears that first contact involved the center fin leading edge of the L-1049 and the left aileron tip of the DC-7. Instantly thereafter the lower surface of the DC-7 left wing struck the upper aft fuselage of the Constellation with disintegrating force. Without question this force caused complete destruction of the aft fuselage and destroyed the structural integrity of the left wing outer panel. As this occurred the aircraft continued to pass laterally, the left fin leading edge of the Constellation and the left wing tip of the DC-7 made contact, tearing off pieces of both components. During this same time the DC-7 No. 1 propeller inflicted a series of cuts in the area of the aft baggage compartment of the L-1049. This entire sequence took less than one-half second.¹⁰⁹

The Flight Investigation

¹⁰⁵ McComb, “Collision Over the Canyon,” 53.

¹⁰⁶ *Arizona Republic*, 30 July 1956. At Ft. Huachuca, forty-one members of the 93rd Transportation Company, 14th Army Aviation Company and 9470th Technical Unit received commendations. At a White House ceremony on August 2, President Eisenhower decorated thirty army and air force pilots for “skill and daring seldom matched in time of peace.” *Arizona Republic*, 3 August 1956. Two air force pilots accidentally left off the list of White House honorees were later decorated. *Arizona Republic*, 2 August 1956. The airmen from Ft. Huachuca and Luke Air Force Base in Phoenix received recognition for risking their lives to recover victims and collecting crucial evidence. Nine army pilots received the Soldier’s Medal, another fifteen received commendation ribbons, and two pilots received both. Furthermore, two air force pilots received the Distinguished Flying Cross and four received the Air Force Medal. *Phoenix Gazette*, 2 August 1956. Seven of the nine Soldier’s Medal recipients (all from the 93rd Transportation Company) would also receive the Distinguished Flying Cross. *Arizona Republic*, 3 November 1956. Six were later commissioned as colonels for their actions. *Arizona Daily Sun*, 3 September 1956. The Flight Safety Foundation honored two army pilots and an air force captain. *Arizona Republic*, 9 August 1956. Seven of the nine Soldier’s Medal recipients (all from the 93rd Transportation Company) would also receive the Distinguished Flying Cross. *Arizona Republic*, 3 November 1956.

¹⁰⁷ CAB, *Accident Investigation Report*, 4-6.

¹⁰⁸ *Ibid.*, 5-6.

¹⁰⁹ *Ibid.*, 15-16.

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As part of its investigation, the CAB also analyzed the flight itself. Both planes were in uncontrolled airspace, where sufficient facilities and the means for such control did not exist. Here pilots operate under visual flight rules, also known as the “see and be seen” principle that depends on the flight crews’ ability to visually provide separation between aircraft. Both planes had also diverted northward over Grand Canyon National Park from their proposed flight tracks, a practice allowed in uncontrolled airspace to take advantage of weather factors.¹¹⁰

Limitations faced by air traffic controllers in an insufficient navigation system, which directly impacted the fate of the two airliners, came forth during the public hearing CAB held in the Department of Commerce Auditorium in Washington, D.C., between August 1 and 4, 1956. The CAB questioned the Salt Lake controller regarding whether traffic advisory information should have been issued to the flights. The controller knew that both aircraft were flying at the same altitude and that both had estimated duplicate arrival times at the Painted Desert line of position. The controller replied that because flights in uncontrolled areas are not required to take a specific track, he did not know what track either flight would take to the line of position. Furthermore, the Painted Desert line of position is nearly 175 miles long. “The estimates from the flights, therefore, did not mean they could converge there but merely that both would pass the line eastbound at that time.” Providing advisory information to flights within uncontrolled airspace was not required and also not possible without control of flights, more definitive position descriptions, and additional facilities and staff.¹¹¹

In its analysis, the CAB cited “the probable cause” for the collision “was that the pilots did not see each other in time to avoid the collision.” Why the pilots had not seen each other in time was inconclusive and could be attributed to a number of variables that had been explored and summarized by the CAB:

[T]he evidence suggests that it [the midair collision] resulted from any one or a combination of the following factors: Intervening clouds reducing time for visual separation, visual limitations due to cockpit visibility, and preoccupation with normal cockpit duties, preoccupation with matters unrelated to cockpit duties such as attempting to provide the passengers with a more scenic view of the Grand Canyon area, physiological limits to human vision reducing the time opportunity to see and avoid the other aircraft, or insufficiency of en route air traffic advisory information due to inadequacy of facilities and lack of personnel in air traffic control.¹¹²

The Aftermath

The Grand Canyon disaster “rocked the aviation world,” as the deadliest in American commercial aviation history at the time.¹¹³ The two giant airliners’ collision over the emptiness of the Grand Canyon in relatively clear weather in broad daylight was especially troublesome. Aviation experts had been warning of a catastrophic mid-air collision over a congested metropolitan area, not the vast expanses of the Southwest. It was, in the words of one CAA official, the “impossible” accident.¹¹⁴ By illustrating the razor thin margin of error that existed in the crowded airspaces above major cities, the collision highlighted the airways crisis.¹¹⁵ As

¹¹⁰ Ibid., 16-17.

¹¹¹ Ibid., 10. Also, this advisory information was only a discretionary duty in the controlled area. The CAA Director of Air Traffic Control confirmed these facts, testifying “that advisory service for traffic in uncontrolled areas would be tantamount to positive control of all traffic which would require personnel, facilities, and equipment not presently available.” CAB, *Accident Investigation Report*, 11.

¹¹² Ibid., 24-25.

¹¹³ Cadwalader, “Air Mystery is Solved,” 151.

¹¹⁴ Rochester, *Takeoff at Mid-Century*, 127.

¹¹⁵ “U.S. Skies Getting Overcrowded, Near Collisions More and More Frequent,” *U.S. News & World Report*, 13 July 1956: 34.

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one commentator stated: “The Arizona accident, tragic as it was, served one good purpose. It focused the attention of the American people on their government and the horse-and-buggy conditions prevailing on our airways.”¹¹⁶

The Eisenhower administration was familiar with the problems plaguing the nation’s airways, however, some lawmakers were largely unaware of the crisis. “In Washington, Congressmen who had never taken an interest in aviation matters went to the library” and began questioning CAA officials. Many congressmen, shocked to discover how primitive the air traffic control system was, listened in disbelief as CAA officials described how aircraft operated under visual flight rules without any ground control.¹¹⁷

In the wake of the disaster, it became obvious that the CAA lacked the resources to implement any meaningful change.¹¹⁸ Only two weeks before the Grand Canyon collision, Congress had reduced funding for CAA’s five-year modernization plan to install radar for positive control above 24,000 feet. Just two weeks after the crash, CAA officials went before the Senate Appropriations Committee with a supplemental request for \$68 million dollars to immediately purchase and install over one hundred new radar units. This approval reduced CAA’s original timeframe for the plan from five to three years. Henry Rothschild, director of the Commerce Department, admitted to a senator: “we would be less than fair with you if we did not tell you that this crash, this recent crash, moved us along at a faster pace, too.”¹¹⁹

Four months after the disaster, funding for aeronautics-related projects skyrocketed. In 1957, James Pyle, director of CAA, asked for and received \$810 million for a new airways plan. Allocations for new airway facilities increased from \$16 million in 1956 to \$125 million in 1958. CAA employment rose sharply with thousands of new hires from 1957 to 1958. Congressional legislators realized “we had a fantastic catching up to do.”¹²⁰ On December 1, 1957, officials also lowered the control floor for positive control from 21,000 to 15,000 feet, and announced plans for twelve “superskyways” that would provide for direct, controlled high-altitude routes for transcontinental commercial flights, decisions no doubt influenced by the 21,000-foot altitude of the Grand Canyon collision. On November 20, 1956, CAA announced that it had awarded a \$9 million dollar contract for 23 long-range radars, the agency’s largest single purchase of electronic equipment to that date. The new radars were to be used primarily for en route air traffic control purposes.¹²¹

The crash also produced a new urgency to break the deadlock over the conflicting civil (VOR) and military (TACAN) air navigation systems. Two months prior to the Grand Canyon collision, one industry expert had predicted that this dispute would continue indefinitely. On August 30, 1956, the Air Coordinating Committee approved a study panel’s recommendation that VOR and TACAN be combined. VORTAC (an acronym used to describe a short-range navigation system, using the VOR directional component and the distance component of TACAN) would become a key element of the civil-military common system of air navigation and air traffic control.¹²²

Although some work had been completed on a Collision Avoidance System (CAS) for aircraft before the summer of 1956, the first concerted attempts to produce a viable device came after the Grand Canyon

¹¹⁶ Ernest Conine, “Russian Roulette on our Airways?” *Harper’s Magazine* 213 (September 1956), 40.

¹¹⁷ Rochester, *Takeoff at Mid-Century*, 128.

¹¹⁸ Michael Nolan, *Fundamentals of Air Traffic Control* (Belmont, CA: Wadsworth Publishing Company, 1994), 24.

¹¹⁹ Rochester, *Takeoff at Mid-Century*, 130.

¹²⁰ Rochester, *Takeoff at Mid-Century*, 130, 146-47.

¹²¹ Terry Kraus to Susan Salvatore, e-mail message to Susan Salvatore, March 30, 2011.

¹²² Ibid.; Rochester, *Takeoff at Mid-Century*, 131-35.

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disaster.¹²³ U.S. airlines then began looking for a warning device that could prevent similar collisions. In 1956, the Air Transport Association (ATA), an association of the major U.S. airlines, held a symposium to compare their requirements for a CAS with current technology. ATA also formed a Collision Avoidance Committee that later merged with the Federal Aviation Agency's Collision Prevention Advisory Group.¹²⁴ A number of companies began research and development on collision alarms for aircraft, the most notable being Collins Radio Company in Cedar Rapids, Iowa. United Air Lines and American Airlines began negotiating with famed electronic genius Art Collins to equip their fleets with his collision alarm system. Collins' system would automatically alert the pilot of any aircraft within a two-mile radius, provide the location of the intruder, and adjust the plane's flight path accordingly.¹²⁵ Clearly, the 1956 Grand Canyon collision spurred the development of CAS technology and laid the groundwork for the modern Traffic Alert/Collision Avoidance Systems in use today.¹²⁶

Creation of the Federal Aviation Agency

In February 1957, Edward Curtis, Eisenhower's special assistant for aviation, unveiled his plan before the President's Advisory Committee on Government Organization. He outlined how to address the organizational and technical deficiencies that had led to the inadequacies of the nation's aviation facilities system. He proposed forming a temporary independent agency, the Airways Modernization Board, devoted to research and development to deal with immediate traffic control needs. In the long term, he envisioned an independent Federal Aviation Agency. Four days later the plan was sent to Congress and released to the public.¹²⁷ In August 1957, President Eisenhower signed the Airways Modernization Act. The act established the short-lived Airways Modernization Board, starting "a new era of sensible control of the nation's airspace."¹²⁸ On May 21, 1958, Senator A. S. Mike Monroney of Oklahoma "introduced...a bill to create an independent Federal Aviation Agency to provide for the safe and efficient use of national airspace by both civil and military operations, and to provide for the regulation and promotion of civil aviation in such a manner as best would foster its development and safety."¹²⁹

The 1956 Grand Canyon aviation accident was not the only air disaster to spur the government into action. Two midair collisions between civilian and military aircraft in the spring of 1958, "dramatically pushed these plans along," particularly demonstrating "the need for unified control of civil and military flights."¹³⁰ One collision near Las Vegas, Nevada, between an air force jet fighter and a United DC-7, killed all forty-seven onboard the airliner, and the second collision over Brunswick, Maryland, between a T-33 trainer and a Capital Airlines, killed two military personnel and all eleven passengers onboard the airliner. In President Eisenhower's special message to Congress on June 13, 1958, he recommended the establishment of a new federal aviation agency: "it had been my intention to submit recommendations for a [F]ederal Aviation Agency to the Congress early in the next session. The recent Maryland collision has made it apparent, however, that the

¹²³ U.S. Congress, Office of Technology Assessment, *Safer Skies with TCAS: Traffic Alert and Collision Avoidance System—A Special Report*, OTA-SET-431 (Washington, DC: U.S. Government Printing Office, February 1989), 3.

¹²⁴ In the fervor following the crash, J. S. Morrell of the Bendix Corporation, produced the first accurate study of the physics involved in collision avoidance. U.S. Congress, Committee on Science and Technology, *Aircraft Collision Avoidance* (Washington, DC: U.S. Government Printing Office, 1979), 4.

¹²⁵ "CORPORATIONS: Genius at Work," *Time*, 24 September 1956, <http://www.time.com/time/magazine/article/0,9171,867144,00.html> (accessed February 25, 2011); Mary H. Cadwalader, "Air Mystery is Solved," *Life*, April 1957: 164.

¹²⁶ Rob Lee, "TCAS: How it Works," *Flight Safety Australia* 8 (July-August 2004), 25; U.S. Congress, *Safer Skies With TCAS*, 3.

¹²⁷ Rochester, *Takeoff at Mid-Century*, 193-94.

¹²⁸ Davies, *Airlines of the United States*, 356.

¹²⁹ Rochester, *Takeoff at Mid-Century*, 194.

¹³⁰ *Ibid.*, 204

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need for action is so urgent that the consolidation [of aviation facilities and air traffic management functions] should be undertaken now.”¹³¹ The imminent arrival of commercial jets also played a central role in these decisions. However, the 1956 collision clearly demonstrated that visual flight rules were obsolete in an era of piston aircraft. After the Grand Canyon disaster, “the thought of a fleet of jetliners flying under visual flight rules was suddenly a thing of horror.”¹³² Thus the crash provided a sense of urgency and a measure of how far air traffic control lagged behind aircraft technology.

¹³¹ “Dwight D. Eisenhower: Special Message to the Congress.”

¹³² Heppenheimer, *Turbulent Skies*, 179.

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Conclusion

The sense of urgency and public demand the 1956 Grand Canyon aviation disaster created were fundamental to the passage of the Airways Modernization Act in 1957 and the creation of the temporary Airways Modernization Board, which one historian extolled as “a new era of sensible control of the nation’s airspace.”¹³³ Federal funds for aviation facilities, which had lagged before the crash, significantly increased afterwards. In addition, civil and military interests resolved their dispute over a common airplane navigation system. This crash, along with the 1958 midair collisions, advanced the passage of the Federal Aviation Act in 1958, which created the Federal Aviation Agency. Reflecting on its rapid passage, Elwood Quesada, the agency’s first administrator, stated, “undoubtedly, the best troubleshooter we had was public demand for change.” The creation of the Federal Aviation Agency marked a significant turning point in the “campaign for a rational, efficient system of aviation planning and policymaking.”¹³⁴

Before the Grand Canyon collision, people in government had been working for months on improving the airways program. Thus, the accident was not a catalyst, but more an elucidator, one that dramatically hastened plans already in motion. “Surely the accident, occurring at a climactic point in the airways crisis,” states historian Stuart I. Rochester, “had a momentous impact. It focused public attention on the air issue, stirred Congress from its ostrichism, and jolted even those insiders who were already cognizant of the collision hazard.” Stuart concludes, “If it was not *the* pivotal event in the campaign for sounder civil air regulation, it was, undeniably, an important watershed.”¹³⁵

¹³³ Davies, *Airlines of the United States*, 356.

¹³⁴ Rochester, *Takeoff at Mid-Century*, 215, 219.

¹³⁵ *Ibid.*, 125-26, 147.

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Previous documentation on file (NPS):

- ☐ Preliminary Determination of Individual Listing (36 CFR 67) has been requested.
- ☐ Previously Listed in the National Register.
- ☐ Previously Determined Eligible by the National Register.
- ☐ Designated a National Historic Landmark.
- ☐ Recorded by Historic American Buildings Survey: #
- ☐ Recorded by Historic American Engineering Record: #

Primary Location of Additional Data:

- ☒ State Historic Preservation Office--Arizona
- ☐ Other State Agency
- ☒ Federal Agency—Department of Interior, National Park Service, Grand Canyon National Park.
- ☐ Local Government
- ☒ University (Northern Arizona University, Special Collection, Cline Library)
- ☐ Other (Specify Repository):

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10. GEOGRAPHICAL DATA**Acreage of Property:** 1,332**UTM References:** REDACTED**Verbal Boundary Description:** REDACTED**Boundary Justification:** REDACTED

The location of this property is restricted information under law:

National Historic Preservation Act of 1966, as amended, section 304, 16 U.S.C. 470w-3(a)

Section 304

[16 U.S.C. 470w-3(a) – Confidentiality of the location of sensitive historic resources]

(a) The head of a Federal agency or other public official receiving grant assistance pursuant to this Act, after consultation with the Secretary, shall withhold from disclosure to the public, information about the location, character, or ownership of a historic resource if the Secretary and the agency determine that disclosure may –

- (1) cause a significant invasion of privacy;
- (2) risk harm to the historic resources; or
- (3) impede the use of a traditional religious site by practitioners.

[16 U.S.C. 470w-3(b) – Access Determination]

(b) When the head of a Federal agency or other public official has determined that information should be withheld from the public pursuant to subsection (a) of this section, the Secretary, in consultation with such Federal agency head or official, shall determine who may have access to the information for the purpose of carrying out this Act.

The location of this property is restricted information under law:

National Historic Preservation Act of 1966, as amended, section 304, 16 U.S.C. 470w-3(a)

Section 304

[16 U.S.C. 470w-3(a) – Confidentiality of the location of sensitive historic resources]

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[16 U.S.C. 470w-3(b) – Access Determination]

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June 11, 2014